ENGINEERING NEWS.

AND

AMERICAN RAILWAY JOURNAL.

VOL. XXXIX. No. 1.

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AN ELECTRIC FREIGHT RAILWAY, known as the Hoboken Shore Line, was opened Jan. 4 at Hoboken, N. J. This road was constructed to facilitate the handling of freight intended for foreign shipment, and connects the wharves and warehouses along the river front of Hoboken, N. J. It is owned and operated by the Hoboken Railroad, Warehouse & Steamship Connecting Co. For several reasons, it was considered advisable to use an electric locomotive, and a 540-HP. machine was built for the company by the General Electric Co., of Schenectady, N. Y. Invitations were extended to a number of gentlemen interested in railway transportation to witness the operation of the locomotive on its first trip. As a test of its hauling ability, a train of 8 regulation freight cars, weighing some 295 tons, was switched and moved back and forth. After the exhibition the entire party adjourned to Myer's Hotel, where dinner was served. Col. E. A. Stevens, President of the Hoboken Shore Line, introduced Messrs. F. La Bau, General Freight Agent of the West Shore R. R.; W. J. Clark, of the General Electric Co., and others, who made appropriate remarks.

THE NORTHWESTERN ELEVATED RAILWAY, of Chicago, has been granted an extension of time for one year, or to Jan. 1, 1899, for the completion of its structure, work on which was stopped some time ago on account of financial difficulties. Work will be resumed in the spring. This line was described in our issue of Sept. 5, 1895.

THE BALTIMORE MUNICIPAL SUBWAY SYSTEM for electric wires planned by Mr. N. S. Hill, Jr., Chief Engineer of the Subway Commission is objected to by the street car companies, according to "The Sun," of that city. They protest that the subways make no provision for the feeders of the electrical railway system, and that they are thus not adapted to present railway use. The real objection is apparently the cost of making the change under the proposed plan. The Consolidated Ry. Co. says it has in constant use 13,000 HP. of electric power; the total number of duct feet of cable used by this company would be about 206,050, and the cost of putting this underground, exclusive of conduit construction, is figured at $300,000. On the other hand, the cost of maintaining the aerial system is $32,000 per year; the duct rental would be over $14,802 per year, at 6½ cts. per foot of duct, and the cost of constructing the ducts is placed at 10½ cts. per foot of duct. The counsel of the Consolidated Company finally says that the total cost of putting the cables underground and rearranging power stations would be about $1,000,000; the company is willing to spend this money to meet the wishes of the people, but it asks the privilege of spending it as it sees fit, for a practical underground system, and to be free from all future rental charges. The telegraph and telephone companies also object to going into the conduits along with railway feeder wires.

PROGRESS ON THE NEW EAST RIVER BRIDGE is reported as follows by Chief Engineer L. L. Buck, M. Am. Soc. C. E., in his annual report: New York side.—Tower foundation let to Patrick H. Flynn, Oct. 28, 1896, for $370,000. North caisson launched on May 15, 1897; concreting commenced May 26 and finished June 15, and first stone laid in masonry on June 28. This caisson was sunk in place on Aug. 2, and first struck bed-rock on Sept. 17, at elevation — 43.5 ft.; sinking stopped on Dec. 1, at elevation — 54.81 ft., and sealing of air-chamber commenced. Pier now completed to elevation 2.54 ft. above mean high water. South caisson, New York side, was launched on Sept. 30; concreting began on Oct. 19, and is still in progress. The contract for the New York anchorage was awarded to Shanly & Ryan on Oct. 5 for $716,770, plus cost of piles used. Work was commenced upon it on Oct. 9 in tearing down buildings and preparing site. Brooklyn side.—Contract for tower foundations let to Colin McLean June 30, 1897, for about $507,000. The south caisson was launched Oct. 19, and the north caisson Dec. 15. Concreting on the south caisson was commenced on Nov. 24, and 1,700 cu. yds. were in place at date of report. Work on coffer dam of north caisson in progress. The contract for the Brooklyn anchorage was awarded to the Degnon-McLean Construction Co. on Oct. 1 for $721,850, plus cost of piles to be used. Work is in progress in tearing down buildings. The plans and specifications for towers and end spans are nearly completed, and the contracts for them will probably be advertised on Jan. 19, 1898. The approximate cost of work now under contract, as above given, aggregates $2,315,620.

THE PROPOSED OHIO RIVER BRIDGE, between Marietta and Williamsport, says Gen. John M. Wilson, Chief of Engineers, U. S. A., must have a clear span of 800 ft. and leave a clear headway of 92.8 ft. above zero on U. S. gage at Marietta. Major Chas. F. Powell, Corps of Engineers, U. S. A., and in charge of local waterways, in reporting on this bridge, says that the site selected by the projectors was unfavorable to navigation, and he made the recommendation noted above. This action concedes all that the rivermen contended for, and the bridge company will have to comply with the stipulated requirements in order to build a bridge.

THE FIRST RAILWAY BRIDGE FOR ALASKA has just been shipped from Tacoma, Wash., says the "Ledger," of that city. It is a 250-ft. span bridge, which is to cross the Skaguay River, on the narrow gage line now under construction across the White Pass to the lakes. Mr. George Keys, the engineer of this line, says that 17 miles of roadbed have already been constructed on this 38 miles of proposed railway. The summit in White Pass is only 2,600 ft. above tide; but 4.5% grades are talked of to overcome it. The bridge is the chief difficulty, and this will be in the main an iron structure.

A BRIDGE ACROSS THE STRAITS OF SHIMONOseki, Japan, is said to be contemplated by the Japanese government, to unite the main line of the Kinsin Ry. with the Sauyo Ry., from Shimonoseki to Hiogo. This strait, at its narrowest part, is a mile wide. The channel is deep, with a swift current, and is traversed by sailing vessels and ocean steamers. The engineering difficulties involved, with its probable great cost, make it unlikely that the project is much more than a paper one, for the present, at least. These straits, however, separating two of the main islands of Japan, make a railway connection very desirable, especially as these sections of the Kingdom lie nearest to Corea and the Chinese mainland.

THE HARBOURG HIGHWAY BRIDGE, ACROSS THE Elbe, says the "Centralblatt der Bauverwaltung," was lately submitted to competition for plans. The conditions called for a metal bridge, with a width of roadway of 19.68 ft. and two footways of 5 ft. each. The railway bridge just below contained four spans of 328 ft. each and six spans of about 98 ft. each. Of the ten plans presented nine of them practically repeated this arrangement; one designer only proposed a mid-span of 668 ft., with two side spans of 333.9 ft. each. This latter arrangement was not a happy one for navigation, as the piers of the railway bridge were only 656 ft. away; and the expense of construction was largely augmented. The competition fixed the maximum cost at $525,000. The four prize plans are described, and the estimated cost and weights are given as follows:

	Total cost.	Weight of metal, River bridge, lbs. per lin. ft.	price per lb.
Firse prize	$450,857	3,823	3.74 cts.
Second prize	410,066	3,051	3.63 "
Third prize	513,422	4,067	5.24 "
Fourth prize	498,604	3,952	3.63 "

A STUDY OF THE NICARAGUA CANAL is to be made by a party of contractors and engineers, who sailed from New York for Nicaragua on Dec. 30, 1897. The party consisted of Mr. Edward F. Cragin and Mr. L. E. Cooley, of Chicago, Ill., and representatives of the contracting firms of Mason, Hoge & Co., of Frankfort, Ky.; E. D. Smith & Co., of Philadelphia, Pa.; Winston Bros., of Minneapolis, Minn.; McArthur Bros. Co., of Chicago; Christie & Low, of Chicago; Chicago Dredging & Dock Co., of Chicago; Illinois Dredging Co., of Chicago, and Washburn & Washburn, of New York. The object of these gentlemen is to go over the line of the proposed Nicaragua Canal, and to make such a study of the country, climate, material, etc., etc.. as will enable them to bid intelligently on the construction should they desire to do so when the enterprise reaches the necessary stage of progress. According to the present itinerary, the party will spend two days in an examination of the Panama Canal, sailing from Panama by Pacific Mail steamer to Corinto; thence to Managua and thence to Rivas. From Rivas the party will begin its trip eastward along the Nicaragua Canal route, crossing Lake Nicaragua by steamer, and thence through the forests to Greytown, the eastern terminus of the canal. The trip will last from six to eight weeks.

The expenses of the trip are paid by capitalists, whom Mr. Cragin has interested in the canal. These capitalists, it is stated, stand ready to invest heavily in the canal as soon as they can gain some guarantee from practical and experienced contractors that the canal can be built within certain limits of cost. This guarantee, it is hoped, may be developed by the present trip. Should it be developed and also prove satisfactory, it is stated that a syndicate of these and other capitalists will be formed to construct the canal as a private enterprise entirely independent of the United States Government.

THE NICARAGUAN RAILWAY and the steamers on the Nicaraguan lakes are for sale or lease by order of government. This railway extends from Grenada, on Lake Nicaragua, to Managua, on Lake Managua, a distance of 33 miles, and connects by steamers with another railway section 58 miles long, connecting Momotombo with Corinto, on the Pacific coast. The two lines are said to have cost the government $2,700,000. U. S. Consul Paul Wieske, of Managua, says that the expenditure of $100,000 gold would put these roads in good working order. The commissioner to be appointed to offer these roads and steamer lines to investors in England and in the United States will visit the latter country first, says Consul Wieske.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred Dec. 28 on the Chicago, Hammond & Western Ry. at a point where the tracks cross Salt Creek, about two miles north of La Grange. An engine and caboose were thrown into 8 ft. of water. Six persons were injured, but it is expected that all will recover.

A FLOOR GAVE AWAY in the City Hall of London, Ont., Jan. 3, precipitating a portion of the audience, gathered to hear election returns and speeches, some 20 ft. to the floor below. Out of the 300 who fell, the latest reports state that 25 were killed and a large number injured. The cause is attributed to the failure of one of the main floor beams, due to overloading, while the fall of a safe and a large steam coil upon the struggling crowd largely increased the number of casualties.

ELECTRIC STORAGE BATTERY CARS ON THE ENGLEWOOD & CHICAGO ELECTRIC RY.

It is a considerable time since much has been heard of the use of storage battery electric cars in regular service, although various experiments have been made from time to time, and many of our readers will be particularly interested in the following account of the Chicago & Englewood Electric Street Ry., which employs this system exclusively, and which has been operating 10 to 20 storage battery cars on about 12 miles of line since June 20, 1897. Two cars, operated by means of a temporary power station, have been in service since Oct. 10, 1896, in order to fulfil the requirements of the franchise. The road has been in a receiver's hands until recently, but has now been sold to a reorganization committee of the bondholders, represented by Messrs. A. S. Heidelbach, J. S. Bache, and I. L. Rice, of New York city, and S. R. Shipley, of Philadelphia, Pa., and it is said that extensions will soon be made.

FIG. 1.—STORAGE BATTERY CAR AND TRAILER; ENGLEWOOD & CHICAGO ELECTRIC RY.

The road was built under the personal direction of Mr. G. Herbert Condict, who designed the system used for charging the batteries, the method of supporting them on the car trucks, and the apparatus for transferring them to and from the cars. Mr. B. J. Arnold, of Chicago, was the Consulting Engineer during construction. Mr. A. E. Davies is the Superintendent. We are indebted to Mr. Arnold and Mr. Condict for photographs, drawings, and information, and have also taken some information from a paper written for the "Western Electrician" by Mr. George A. Damon.

The line as now built extends southward from 63rd St. and South Park Ave. (where there is a station of the South Side Elevated R. R.) to Blue Island, a distance of 12 miles, with a branch 1½ miles long, to Morgan Park. The line will eventually be extended to Harvey, and its franchise includes a number of east and west lines, aggregating about 35 miles. There are now nine miles of double track and 3½ miles of single track. The road has a number of sharp curves where it passes from one street to another, but it has few grades, the maximum grade being one of 9% for a length of about 800 ft. at Morgan Park, but on this grade a counterweight system is used. The counterweight is a car or truck of 21 tons weight, running in a conduit under the track and being attached to a ¾-in. wire rope which passes over a pulley at the head of the grade and is attached to a grip which passes up through a slot between the rails. A descending car is attached to the grip, and pulls the counterweight to the head of the grade. An ascending car is then attached to the grip and is assisted by the counterweight as the latter runs down the conduit. The conduit is of 2-in. plank, with iron yokes set in concrete, about 28 × 56 ins. inside, with a track of 24 ins. gage. It may be noted here, however, that on one occasion of heavy traffic in one direction, when the ascending cars followed one another very closely, it was necessary for these cars to ascend without the aid of the counterweight. This they did without trouble, one motor car hauling two trail cars up the grade, all the cars being heavily loaded.

The cars are now run on a winter schedule, giving a headway of 20 minutes between 63d St. and Blue Island, and the same interval for cars between 79th St. and Morgan Park. The average traffic is about 4,000 passengers per day, while on Sunday this increases sometimes to 15,000 passengers, much of this traffic being on account of the various cemeteries reached by the Morgan Park branch. The maximum daily traffic was 17,000 passengers, this being on a Sunday when a monument was to be dedicated at one of these cemeteries. There are about 15 cars in regular daily service during the summer, and 20 cars (with from one to three trailers each) on Sundays. The regular force includes 25 motormen and 25 conductors.

Track.—On account of the weight of the cars it was necessary to build a substantial track so as to give an easy riding road and prevent undue expense for maintenance and repairs. The entire line is laid with 80-lb. girder rails, 7 ins. high, with joints spliced by heavy splice bars and six bolts. The joints are not bonded. The rails are spiked to oak ties 8 ft. × 6 ins. × 7 ins., spaced uniformly 24 ins. c. to c., with tie plates to each tie, every third tie having a combination tie-plate and rail-brace, while a tie bar ⅜ × 1½ ins., bolted through the rails and splice bars at each joint assists in maintaining the gage. The ties rest on 6 ins. of gravel ballast.

Cars.—All the cars are carried on four wheels, and the present equipment consists of 20 closed motor cars (with vestibuled ends), 16 open motor cars and 20 open trail cars; also a street sprinkling car (which is sometimes utilized as a locomotive) and a track sweeper for clearing off snow. The cars were built by the St. Louis Car Co., of St. Louis, Mo., the motors, controllers, etc., being furnished by the Walker Co., of Cleveland, O. The closed cars are 20 feet long in the body, 30 ft. long over the platforms, and have seating accommodations for 28 passengers. The open cars have ten transverse seats. The trucks are of the Dupont pattern, with 33-in. wheels and a wheelbase of 9 ft. 3 ins., this being more than usual in order to give ample room for the batteries, which are carried on the truck frame (between the axles), instead of inside the car. Each motor car has one 50-HP. Walker motor, mounted on the outside of one of the axles, so as to leave clear the space between the axles. The trail cars weigh about three tons, empty. The closed motor cars weigh about 13½ tons, with batteries, the batteries themselves weighing 3½ tons. They make a trip of 26 miles with one charge, the time being about two hours, although the cars could be run 30 or 35 miles. The average speed is 12 to 13 miles per hour, but a speed of 25 miles per hour has been attained. The sprinkler car has a cylindrical tank of 3,500 gallons capacity, and weighs, empty, about 12 tons. The snow sweeper weighs, with batteries, about 22 tons, and has three 50-HP. motors and three sets of batteries, the extra battery and motor driving the revolving brooms. The controllers are of special design, having larger contact surfaces than usual on account of the low voltages and the large current used. They are arranged for five combinations, as follows: 1. The four groups of batteries in parallel, giving a current of about 36 volts; 2. The batteries in series-parallel, in groups of two, giving a current of about 72 volts; 3. The batteries in series, with resistance; 4. The batteries in series without resistance; 5. The batteries in series without resistance, and the field of the motor shunted.

An open motor-car, with trailer attached, is shown in Fig. 1, and the side of the battery tray appears between the inner sets of helical springs on the truck frame.

Batteries.—The wooden battery box or tray is 5 ft. 9 ins. long, 4 ft. 7 ins. wide and 10 ins. deep, with brass contact plates on the sides, which automatically effect the electrical connections on the car and in the charging room. In the tray are 72 cells, consisting of hard rubber jars, 5¼ × 8½ ins., and 17¾ ins. deep (outside), arranged in twelve rows of six cells. In each jar are five chloride negative plates, 14¾ × 7¾ ins., and ¼-in. thick, and four Tudor or Manchester positive plates, of the same size, but 5-16-in. thick. There are no bolts or screws about the cells, the plates being connected by strips of lead electrically welded, and the batteries being connected up in four groups of 18 cells each, with flexible cables connecting each group to the large brass contact plates on the sides of the tray. In the top of each jar is a hard rubber crate, which prevents the slopping or splashing of the acid, but this is not always used, as it is not found to be necessary. In each cell the jar weighs 5 lbs.; the ele-

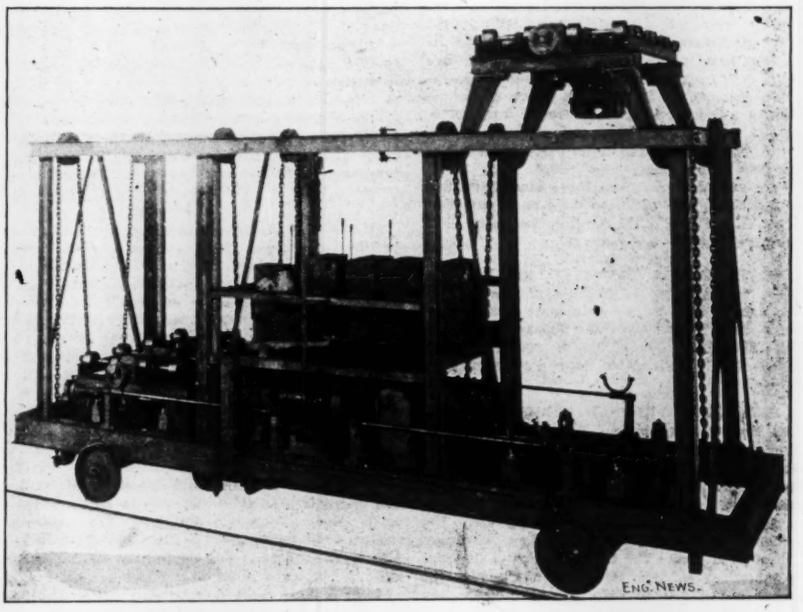


FIG. 2.—TRANSFER CARRIAGE FOR HANDLING STORAGE BATTERIES.
Shaw Electric Crane Co., Builders.

ments, 75 lbs.; and the electrolyte, 20 lbs., making a total of 100 lbs., or 7,200 lbs. for all the cells, while the weight of the tray brings this up to 7,800 lbs., or nearly 4 tons. The set of cells forming the battery will, when in series, deliver a current of 400 amperes at 145 volts. Some of the batteries

FIG. 3.—BATTERY BEING MOVED FROM CHARGING TABLE TO TRANSFER CARRIAGE.

have run 10,000 miles in four months, and are still in good condition. The batteries were supplied by the Electric Storage Battery Co., of Philadelphia, Pa.

For the process of recharging, the exhausted battery is removed from the car (by the method described below) and deposited on the charging table, where the contact plates on the sides of the tray make connection with the spring contact plates on the table, and thereby complete the charging circuit. In order to charge the battery at a given rate, a current of constantly increasing voltage is required, for, if the voltage remained constant the current received by the battery would be reduced as its electro-motive force increased, while if a current of the highest voltage required were to be applied at once to the exhausted battery, it would cause injury to the plates. To accomplish this variation in the charging current, three dynamos are run at voltages of 160, 172 and 180 volts, and three cables (with a single negative return) are led from the switchboard to the charging tables, and the battery tray can be connected to either cable by a plug switch. The exhausted battery is first connected to the cable of lowest potential, the charging current is started at 150 amperes and gradually reduces to 30 amperes; it is then connected to the second cable, which again gives a charging current of 150 amperes, and when this has fallen, as before, the battery is connected to the third cable, by which the charging is completed. The batteries are charged in from 40 to 60 minutes, and at this rate the number of batteries required is only 50% greater than the number of cars in service.

Removing and Renewing the Batteries.—One of the most interesting features of the power station is the method of removing exhausted batteries from the cars and replacing them with charged batteries, the system being designed to require as little time and expense as possible. As already noted, the battery is carried by the truck frame, entirely independent of the car body, and all the handling is done from below by a transfer car operated by one man. The operation of this transfer car will be readily understood if we compare it to the trolley of a traveling crane, running under instead of over the building, and being fitted with two elevators instead of a hoisting chain and drum. This carriage is shown in Figs. 2 and 3. The operator stands in the middle of the carriage, as shown in Fig. 3. The carriage runs on a track in the basement of the car barn, with charging tables on each side, and the floor of the car barn is open over this pit so that the batteries and motors on all the cars stored in the barn are accessible from below. This charging pit or battery room is 30 ft. wide and 9 ft. deep below the level of the car tracks, the portion traversed by the transfer carriage being 3 ft. deeper. This is shown by the cross section Fig. 4.

The car to be charged is run into the arcade forming the front end of the power station by a loop line from the street, and stops with the battery directly over an opening above the transfer car track in the basement. The transfer carriage is normally in position waiting for the car, with the elevator on its front end empty and directly under the floor opening already noted, while a charged battery is on the rear elevator. When the car stops, the man on the transfer carriage raises the elevator until it lifts the battery from its support on the truck frame; and then, by a lever, throws back the supporting bars, and lowers the elevator with the battery upon it. When this is lowered, he moves the transfer carriage forward until its rear elevator is under the opening. The elevator raises the tray into position and then drops it on to the supporting bars, which automatically spring into place under the hooked supports on the battery tray, and the brass contact plates on the side of the tray automatically make connection with the motor by means of spring contacts on the car. The operator then lowers the elevator clear of the car, and gives a bell signal that the operation is completed, and the car then proceeds upon its journey, having been at rest for only about 1½ minutes.

The transfer carriage is then run back to deposit the exhausted battery on the empty charging table at the side of the pit. When the carriage is stopped, its operator throws a clutch which connects a shaft on the carriage with a shaft on the table, and by means of skew-bevel gears these shafts drive rollers on which the battery tray rests, so that when the operator puts in motion the shaft on the carriage it causes the rollers on the elevator and the table to revolve, and thus convey the battery from the elevator to the charging table. He then stops the shaft, releases the clutch, moves the carriage along to a table occupied by a charged battery, throws the clutch, puts the shaft in reverse motion, and thus causes the rollers to transfer this battery from the table to the elevator of the carriage. This is shown by Fig. 3, in which one battery is half off the charging table, while two others are in position on their tables.

The transfer carriage was built by the Shaw Electric Crane Co., of Muskegon, Mich., and is about 21 ft. 6 ins. × 6 ft. 9 ins., and 10 ft. 2 ins. high, carried on four 18-in. double-flanged wheels running on a track of 6 ft. 3 ins. gage in the pit, while its elevator tables are 5 × 5½ ft., with a total lift of 8 ft. 3¾ ins. The nominal lifting capacity of each elevator is 4 tons, but the builders state that the machine is proportioned to resist a strain of twice that amount on account of the shocks and the extra load due to forcing the batteries into position on the car trucks. The weight of the machine, ready for service, is about 25,000 lbs. The carriage has a heavy framework of I-beams, the top part of the frame carrying the upper sheaves for the elevator pulleys. In Fig. 2 the right hand elevator is raised and the left hand elevator is lowered, and the operator's platform is between the two elevators.

The carriage has one 12-HP. motor to run it along the track, one 22-HP. motor to each elevator, and one 3½-HP. motor to each set of rolls, or five in all. The operating current is supplied from the charging circuit. To ensure reliability in operation, the machinery is so interlocked that the carriage cannot be moved until the elevator is lowered clear of the car above, and the elevators and trays cannot be moved until the carriage is in proper position under the car or opposite the charging table.

Power Station.—The power station is situated at 88th St. and Vincennes Road, close to the Chicago, Rock Island & Pacific Ry., a side track from that road enabling cars to deliver coal at the back of the boiler house. It is a brick and stone structure, with steel roof trusses, and contains a car barn, boiler room and engine room, while on the second floor of the front of the building are the company's offices, the offices for the superintendent and his assistants, and also the toilet rooms (with shower baths and lockers), and reading room for the use of the conductors and motormen. The car barn is at present 157 ft. long and 101 ft. wide, with thirteen tracks accommodating 26 cars, the cars being in two rows, one on either side of a transfer table. Each car stands over an opening in the floor, so that its batteries and motors can be handled by the elevators of the transfer carriage in the basement, as already noted. Eventually the length of the building will be increased to 258 ft., with accommodation for 50 cars, which is the number for which the power station and plant are designed.

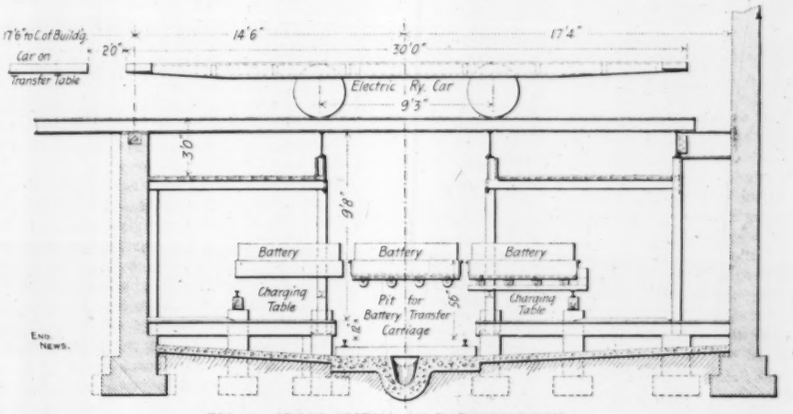


FIG. 4.—CROSS SECTION OF BATTERY ROOM.

The charging pit is in the basement of the car barn. The boiler room is 37 × 73 ft., and the engine room 30 × 73 ft., the latter containing the engines, dynamos and switchboard, and having the feed pumps, condensers, etc., below the level of the main floor along the partition wall between this room and the boiler room. Across the engine room runs a traveling crane of 15,000 lbs. capacity, built by Pawling & Harnischfeger, of Milwaukee, Wis., and at one end is a visitors' gallery. The floor is of marble tiling, and the lower part of the walls is also covered with marble. The power station was built by Jacob Rodatz, of Chicago.

Power Plant.—The engine room is now equipped with two Willans vertical compound central-valve engines, each having two dynamos at one side. The two inner dynamos are at present connected by a length of shafting, but later on, when the plant is enlarged to its full capacity, there will be another engine between the two pairs of dynamos, as shown in Fig. 5. The three engines and four dynamos will occupy a floor space of only 56 × 12 ft. As already noted, the batteries are charged at three different voltages, and it was therefore necessary to have three dynamos in operation, with a fourth dynamo for relay. The two engines are of 250-HP. each, with two sets of cylinders to each engine (the cranks being set at right angles), and they were built by the Bullock Mfg. Co., of Chicago. The middle engine is intended to be of 500-HP., with four sets of cylinders. This type of engine has tandem cylinders, the high pressure on top exhausting into the low pressure beneath by means of a hollow piston rod.

by an engine not adjacent to it, then the flange couplings of the shaft will be connected to the engine flywheel and the flange of the quill of the dynamo to be driven. Bolted couplings are used, but had the plant been built for a trolley railway or an electric light station, so that temporary stoppages to change couplings would have been prohibited, magnetic couplings would have been installed, so that any engines or dynamos could be connected or disconnected at will, without stopping, by means of a switch. The bed plates of the engines and dynamos rest on brick piers on concrete foundations.

In the boiler room are three Heine water-tube boilers carrying 185 lbs. pressure, and fitted with Roney grates and Roney automatic stokers, the latter being driven by a curious little engine with an inverted oscillating cylinder. When the plant is increased to its full capacity three more boilers will be installed. Coal is delivered from the cars on a firing platform level with the hoppers of the stokers. The feed water is supplied either from the city water mains or from an artesian well at the station, and the exhaust steam is condensed and the water thus obtained utilized again for the boiler feed. It is condensed in Worthington jet condensers and pumped by Worthington pumps, while the water of condensation is cooled in a Worthington cooling tower. This latter apparatus is a steel cylinder about 12 ft. diameter and 30 ft. high, with rows of vitrified sewer tile set on end and so arranged as to form a large area over which the water flows as it is delivered at the top of the tower from a horizontal spider of pipes revolved by the pressure of the

bars for high, medium or low voltage. The other switch connects the negative lead (which is first passed through a recording ammeter and a circuit breaker) with the common negative bus-bar. The four bus-bars are at the back of the switchboard. The switches on the fifth panel control the circuits leading to the motors operating the battery transfer carriages, the car transfer table, the cooling tower fan, etc., while a special switch enables the motor bus-bars to be connected to the main bus-bars for high, medium or low voltage, or to any one of the four dynamos.

The plant is operated by three shifts of three men each; an engineman, a fireman, and a man on the battery transfer car. Besides these, about four men are engaged on car repairs and general work about the station. It is estimated that the cost of the power station and plant, when completed to the full intended capacity of 1,000-HP. will be about $86 per HP.

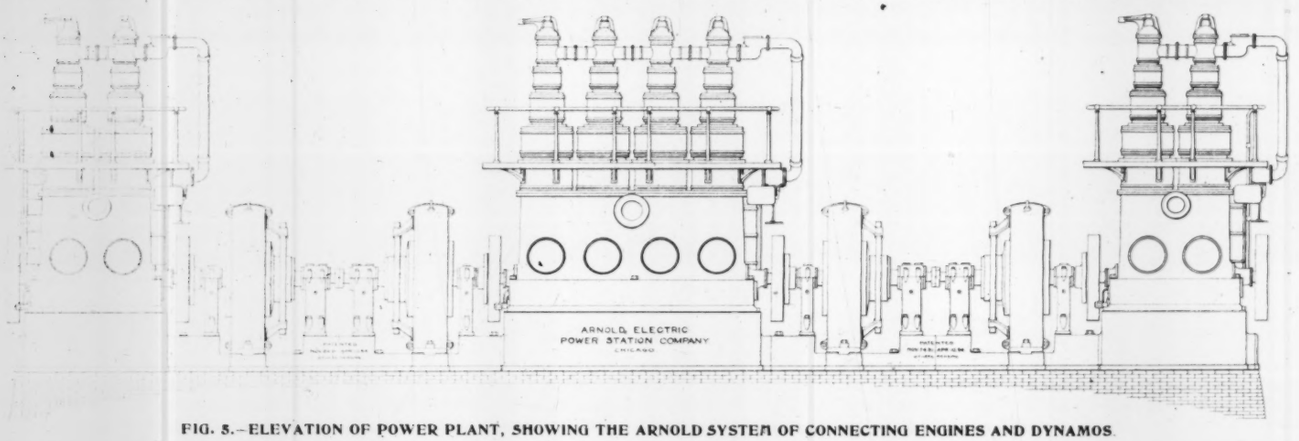


FIG. 5.—ELEVATION OF POWER PLANT, SHOWING THE ARNOLD SYSTEM OF CONNECTING ENGINES AND DYNAMOS.

The engines run very steadily and with little vibration at a normal speed of 380 revolutions per minute. The four dynamos are of the multipolar type, rated at 190 kilowatts each, and were built by the Walker Co., of Cleveland, O.

A special feature of the plant is the Arnold patent system of connecting the engines and dynamos so as to give the greatest flexibility, any engine being able to run any or all of the dynamos. When the middle engine is in place, it can be used to operate the three dynamos used in regular service, the two end engines and one dynamo being then at rest; or it can run any two of the dynamos and one of the end engines can run the third dynamo; or the middle engine can be stopped and any three of the dynamos run by the two end engines, as at present. Fig. 5 is a sectional elevation of the plant, and an examination of the drawing will show that the armature of each dynamo is mounted on an independent hollow shaft or "quill" carried in the bearings (P P) (p p). Through the center of this hollow shaft, but not in contact with it, runs a solid steel shaft (E), carried only by the bearings (D) (d). The outer end of each quill, and both ends of the shaft, are fitted with flange couplings which can be bolted to the engine flywheels (h) (of the end engine) or (H) (of the middle engine). At present the temporary shaft is connected at A. With the middle engine driving the two dynamos adjacent to it, and with the third dynamo driven by the end engine adjacent to it, the solid shaft will be idle, the engine flywheels being connected directly to the flange couplings of the quills. But if it is desired to operate a dynamo

water. As the water flows and drips down it is cooled by an upward blast of air from an 84-in. fan driven at a speed of 275 revolutions per minute by an electric motor of 9-HP. The mixture of injection water and condensed steam delivered from the condenser has a temperature of about 110°, while the water from the cooling tower used for the injection jets has a temperature of about 90°. The feed water is taken from the condenser well and passes through a Green fuel economizer, which is heated by the products of combustion on their way to the smokestack, and by this means the feed is heated to a temperature of about 270°. The condensers, feed pumps, etc., are placed in an open pit at the back of the engine room, this pit being reached by two stairways from the room or a doorway from the boiler room. The smoke and gases from the boilers, after passing through the fuel economizer (or through a by-pass), are delivered into the smokestack, which has a square brick base, 21 ft. high, surmounted by a steel chimney 7 ft. diameter and 143 ft. high, the total height being 164 ft.

The switchboard is of white marble, 21 ft. 8 ins. long and 7 ft. 6 ins. high, and is placed behind the engines. It has five panels, one for each dynamo and the fifth for the motor switches. Each dynamo panel has two single-throw switches, a Weston ammeter, a Weston voltmeter, a Bristol recording ammeter, two circuit breakers, and a rheostat for controlling the voltage of the dynamos. One of the switches can connect the positive lead of the dynamo (which is first passed through a circuit breaker) with either of the three bus-

straight course of about ¼ mile has been laid out, marked by stakes at short intervals, and over this the launch and model are run at different speeds; the resistance is observed and the time of passing the intermediate stakes noted, so that any variation in speed for a given run may be detected.

Cornell University.—Two large pamphlets recently issued by the University are the Annual Report of President Schurmann, and the Register for 1897-98. The annual report points out that the University has more than held its own in numbers while making, since 1894, a continuous advance in entrance requirements. It contains an account of the new hydraulic laboratory and canal, with a reservoir covering 23 acres and holding 53,000,000 gallons of water, together with a statement of the investigations which it is proposed to make in hydraulics. The Register shows that the total number of students in the University is now 1,790. The Sibley College of Mechanic Arts and Mechanical Engineering is the largest professional school in the University, and now enrolls 463 students.

New York University.—Mr. Andrew Carnegie has presented a set of geological and mineralogical specimens from the largest iron mines in the Northwest, with cases. Three friends of the University have presented $4,000, to be divided between the departments of geology, biology, engineering and physics. Dr. William Allen Butler has been elected president of the Council, in the place of his father, Dr. Charles Butler, recently deceased.

NOTES FROM THE ENGINEERING SCHOOLS.

Massachusetts Institute of Technology.—Experiments are now being conducted by two students in the Course in Naval Architecture, on the "Determination of the Resistance of a Ship" by means of a small model. The results will be used in their thesis. The experiments are being carried on on the Charles River, near Waltham, the model being that of the U. S. S. "Yorktown" (about 10 ft. in length). The model is towed ahead of a small steam launch by means of a long spar, its resistance, or the pull on its tow-line, being accurately measured by a spring-dynamometer. A

FORESTS AND RAINFALL.*

By Prof. H. A. Hazen.†

Can it be possible that the cutting away of forests affects the amount of precipitation in any locality? To many, no doubt this question will seem easy of answer, but we find the results of study by no means reassuring, and recent investigations have led to almost diametrically opposite conclusions depending, somewhat at least, upon the feeling of the writer. The following paper is prepared from the standpoint of a meteorologist, and is an attempt to present facts.

Formerly, the historical argument was a favorite one. I quote one of these:

> It is a familiar fact that there are many regions in Asia and Southern Europe, once exceedingly fertile and densely populated, that are now utterly sterile and desolate. The country bordering on the Euphrates and portions of Turkey, Greece, Egypt, Italy and Spain are now incapable of cultivation from lack of rain due to deforestation.

Such quotations and statements might be made to fill a large volume. Without more precise data as to rainfall, it would be hazardous to conclude that we have here a case of cause and effect. It is certain that the fertility of these regions in ancient times was due to stupendous irrigating devices and canals, and when these were neglected, through wars and other untoward circumstances, the fertility necessarily ceased. It is certain that there are ruins of enormous irrigating ditches and canals in Babylonia, where history indicates that there was once a teeming population and great fertility, but where now only a sandy desert greets the eye.

Some have said that where our densest forests are found there we have the greatest precipitation. There is no way whereby we can see that such forests would have started unless favored by rainfall, so that the presence of the forest rather indicated the earlier occurrence of practically the same rainfall as at present. Meteorologists are agreed that there has been practically no change in the climate of the world since the earliest mention of such climates. Plants found in mummy cases in Egypt that were plucked thousands of years ago show the same size as those now found in that land.

The strongest argument adduced in the past to show the influence of forest on rainfall has existed in a comparison between rain-gage measures in the forest and the open field. Such records have been made for more than 30 years in France and Germany, and surely we must have here, if anywhere, a sufficient proof of a forest's influence.

Admitting that we have perfect instruments and careful observers, there still remains a most serious doubt as to the immediate environment of each gage and as to the possibility of a direct comparison. It is probable that no two gages 2,000 ft. apart can be placed so as to catch the same amount of rain, though to all appearances the exposure is faultless in each case.

One of the best of all researches in this line has been conducted at Nancy, in France. Within a distance of 5 or 6 miles there have been four stations established—at Nancy, in the open, and at Belle-Fontaine, in the forest; and, 500 ft. higher vertically, Amance (open) and Cinq-Tranchées (forest). The latter stations are in a more hilly region and cannot be compared together, as can the former. At the lower stations we have comparative observations for 25 years. I have summed these in three groups, containing 8, 8 and 9 years in each group. First group, Nancy (open), had 31.16 ins., while Belle-Fontaine (forest) had 32.46 ins.; second group, 33.39 ins. and 34.07 ins.; third group, 30.05 ins. and 29.89 ins. We see that while the first eight years showed a very slight excess in the forest rainfall over that in the open field, in the last nine years (including 1894, last published) the open station showed a little more rain than the forest station. These observations were made with particular care, for the purpose of exactly determining the influence, and may be relied on if the environments of the gages were comparable. At Amance (open) and Cinq-Tranchées (forest) the observations have not been quite so regular, though we have 25 full years of records at these two stations, but not the same years as at the other stations. Amance shows 26.70 in. and Cinq-Tranchées (forest) 33.39 ins., or an apparent preponderance of 6.7 ins. a year in the forest. This would make over 20% greater rainfall in the forest than in the open. It should be borne in mind, however, that these two last stations are on an eminence, and are not strictly comparable, and this result can not vitiate that at the two other stations, which shows no effect.

In Germany we have a rather remarkable record of a slightly different character. Lintzel is a station on the Luneburg heath, and began to be planted with trees in 1887, at the rate of 1,000 to 1,500 acres a year, and in a few years over 8,000 acres were covered. In the midst of this forest is the meteorologic station in an open field of some 75 acres. Before planting the forest 97% of the surface was field, meadow, or heath, and afterward 80% was forest and 20% was roads, open field, and heath. Around this station, pretty evenly distributed, and within 50 miles, there are 13 rainfall stations, which have been carefully established and presumably are comparable with the Lintzel station in the midst of the growing forest. There is no means of knowing whether any of these stations have been changed or not, but for our purpose we may consider the material homogeneous and treat it accordingly. Records from 1882 to 1896 are available. Charts were prepared for each year showing the ratio between the Lintzel record and that at each station of the 13. There is no space for these charts, but, in place of them, I give here the mean of all the 13 station ratios for each year: 1882, 81; 1883, 83; 1884, 101; 1885, 103; 1886, 82; 1887, 98; 1888, 93; 1889, 122; 1890, 97; 1891, 100; 1892, 90; 1893, 96; 1894, 142; 1895, 128; 1896, 136.

These figures are extremely significant, and may be further elucidated as follows: The smaller ratios show a less rainfall at Lintzel, or, these figures are the percentage of rainfall at Lintzel as compared with surrounding stations. It is impossible to determine whether these trees have reached the culmination of their effect or not. In 1896 most of them would be 17 years old, and the ground would probably be fairly covered. It is a great pity that the environment was changed or some accident happened at Lintzel so as to vitiate the three last years. (An inquiry was sent to Germany regarding the error, but no response has yet been received.) The record does not seem to show any appreciable effect upon the precipitation; in 1884 the ratio was 101, while in 1893, nine years later, it was 96. It is probable that no definite and unassailable result can ever be obtained either by the method adopted in France or this later one in Germany. The rainfall is so variable within a distance of even a mile or two, and it is so difficult, if not impossible, to obtain similar environments at all the stations, that no decisive result can be obtained. It will be seen readily that the multiplication of stations will do no good, and above all, that the observation of rainfall under trees in a forest is absolutely useless for any such discussion or study as this.

It seems probable that if two or three lines of stations could be established a mile or two apart on four sides of an enormous forest, each line to have a dozen stations or so, about 3,000 ft. apart, four of the stations to be outside of the forest and the others each in a large, cleared space of at least two acres extent in the forest, something decisive might be obtained. It should be noted, however, that from the evidence already accumulated there would be very little to be gained by a further study of the question. It is certain that the effect, if there be one, is almost inappreciable. The favoring conditions over the forest are balanced by those not favoring and the integrated effect is practically the same in the two cases.

† U. S. Weather Bureau, Washington, D. C.

*Abstract of a paper presented at the annual meeting of the American Forestry Association at Nashville, Tenn., Sept. 22, 1897.

STREAM FLOW IN RELATION TO FORESTS.

Diametrically opposing views regarding the effect of forests on the total flow or runoff of streams have been advanced in the last three years before the American Forestry Association. In 1895, Mr. C. C. Vermuele, of 203 Broadway, New York city, presented a brief paper to the association, in which he stated, as the conclusion of extensive studies, that in the New England and Middle States forest areas have no effect upon the total yield of drainage areas, the most important controlling factor being temperature. At the recent meeting of the Association at Nashville, Tenn., Mr. Geo. W. Rafter, M. Am. Soc. C. E., of Rochester, N. Y., submitted a long paper containing many record figures and other data from which he drew the conclusion that forest areas materially increase total runoff; and while not denying that there is a relation between temperature and runoff he believes Mr. Vermeule lays so much stress on this "as to in effect invalidate any conclusion he may have put forth on the subject under discussion." Although differing as to the effect of forests on total runoff, both gentlemen agree that forests are great equalizers of flow, which, with other inherent advantages, are sufficient reason for their preservation. The two writers agree further in using the term evaporation as including all water that does not reach the stream in question, or the difference between rainfall and runoff. They differ in that Mr. Vermeule uses forest areas in a far broader sense than Mr. Rafter, including areas in brush, which Mr. Rafter excludes.

The studies by Mr. Vermeule were made as consulting engineer of the Geological Survey of New Jersey, in connection with an investigation of the water supply of that State. They are set forth at length in Mr. Vermeule's report on "Water Supply," being Vol. III. of the Final Report of the State Geologist, issued in 1894; and also in the annual reports for 1895 and 1896. The studies by Mr. Rafter have been made in connection with his investigations of water storage on the Genesee River, and of the water supply possibilities of the Upper Hudson, and will be found in detail in an appendix to the Report of the State Engineer of New York for 1896.

Mr. Vermeule bases the conclusions in his paper on studies of the New Jersey gagings made under his directions for periods of four years or less, coupled with rainfall measurements made by the State Weather Service, and also on gagings of the following streams for the periods named: Sudbury River, Mass., 16 years; Connecticut, 8 years; Croton, N. Y., 14 years; Passaic, N. J., 17 years; Hackensack, N. J., 8 years; Tohickon, Neshaminy and Perkiomen Creeks (near Philadelphia), 7 years; Potomac River, 6 years. The various streams have from 7 to 88% of their drainage areas in forest.

Before citing figures Mr. Vermeule states that

> the important fact was developed by these studies that the amount of rainfall evaporated is never directly proportioned to the total rainfall, as is so often assumed to be the case. Evaporation is increased slightly for increased rainfall, but rapidly with increased temperature of the atmosphere. Stream-flow was found to be mainly a function of rainfall and temperature, and little or no effect upon the total yearly runoff was traceable to forests or other vegetation, or to topography.

As to the best method of studying the subject, Mr. Vermeule says:

> I know of no more accurate way to compare the relative evaporation from forested and deforested areas than by measuring the rainfall and the amount of rain flowing off, provided the observations are long enough continued and begin and end with full ground water. In this way we obtain natural conditions and include both direct evaporation from the soil and also the water drawn up by vegetation, much of which is exhaled into the atmosphere. The loss into the earth, which does not reappear in the natural drainage channels, may, under ordinary circumstances, be neglected. This method is certainly far preferable to the attempts to measure evaporation on a small experimental scale, which have frequently been made, and the results of which have been quoted. Some of these measurements entirely neglect the large drafts of moisture made by the trees of the forest. All of these fail to obtain the same conditions which prevail naturally over larger areas of forest.

The author next states that in the Passaic drainage area, with an average annual rainfall of 45 ins., the amount taken up by vegetation was only 6.03 ins., or but 27% of the average annual evaporation of 22.7 ins. This is cited as showing the minor effect of vegetation on evaporation, and thus on runoff. Mr. Vermeule asks: "If evaporation is so much less from forested than from cultivated areas as is sometimes claimed, should not forests be found thriving in full variety and luxuriance far beyond the limit where rainfall becomes too light to support other vegetation?"

The effect of forests upon the greatest and least flow of streams Mr. Vermeule believes to be small, the maximum freshet usually occurring either when the ground is frozen or in summer after becoming saturated with rain. The minimum flow occurs after a long draft upon the water stored in the ground. Thus both maximum and minimum flow are dependent on surface geology and not on vegetation. On the other hand, forests tend to an equable stream flow, "fewer floods and shorter periods of extreme low water," besides which they hold the top soil in place, thus preventing barrenness, the worst possible condition of a drainage area.

Coming now to Mr. Rafter's paper we find that he criticises Mr. Vermeule's conclusions, (1) because based largely on New Jersey data for short periods, and (2) because "he ignores all of the valuable data of forest meteorology which have been obtained abroad and which cannot be safely ignored by any person attempting to study this question on its merits." Mr. Rafter then proceeds, first of all, along the line pursued by Mr. Vermeule, considering total rainfall and runoff. The records considered by Mr. Rafter are for the following drainage areas and periods: Sudbury, Mass., for 21 years, and Croton, N. Y., for 27 years, against 16 and 14 years, respectively, taken by Mr. Vermeule; Cochituate, Mass., for 33 years, and Mystic, Mass., for 18 years; Upper Hudson, N. Y., seven years; Genesee River, N. Y. three years; Muskinghum River, O., eight years; Des Plaines River, Ill., four scattering years; Upper Mississippi, partial data for eleven years.

As a result of a study of the detailed records for the above streams Mr. Rafter concludes "that the deforestation of a drainage area will, in the State of New York and in that vicinity, probably decrease the annual water yield of the area from

4 to 6 ins." This conclusion he says is tentative and he reserves "the right to modify it as further data are gathered."

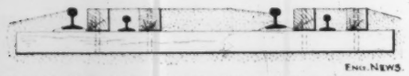
Mr. Rafter's figures emphasize, for the areas under consideration, the persistency, as he terms it, of evaporation in amount, year after pear, it tending to remain constant, without regard to the amount of rainfall. This persistency was first pointed out, Mr. Rafter believes, by Messrs. Lawes, Gilbert and Warrington, in a paper on "The Amount and Composition of the Rain and Drainage Waters Collected at Rothampsted," published in the Journal of the Royal Agricultural Society of England for 1881.

In considering how "deforestation may not only affect floods" but also lead "to an actual decrease in total runoff," Mr. Rafter first calls attention to observations which show that forest temperatures are less than those in the open; that evaporation from both water surfaces and littered soil are much less in the forest than in the open; and that evaporation is less, even at zero temperatures, in still air than in air currents, so that the smaller velocity of wind in the woods would also lessen evaporation. He also considers at length the amount of water required to support various classes of vegetation, concluding that forests take up far less water than areas in crops. In some sections the gradual diminution of forest areas is accompanied by an increase in the area of land under cultivation, which Mr. Rafter holds must materially decrease the total runoff, especially during the growing period. As an illustration of this point he presents figures for the various areas in crop and in forest in Wyoming Co., N. Y., by decades, from 1850 to 1890. By using figures established by experiment as the amount of rainfall in inches required for various crops he shows that the amount of water required to support vegetation in this county in 1890 was 3.4 ins. more than in 1850.

Regarding the effect of deforestation on maximum floods Mr. Rafter says that "it does not per se necessarily materially increase" their height, thus agreeing substantially with Mr. Vermeule.

A PRACTICAL TEST OF A SAND-CATCH SID NG.

Owing to a serious accident at the Dresden-Neustadt railway station, where there is a heavy down grade of 1 in 55, a sand siding was constructed. This siding, built as shown in the accompanying cut, taken from London "Engineering," is 1,641 ft. long, and of this distance 1,148 ft. are covered with sand. All freight trains are required to stop at the head of the grade; if they do so they are shunted into the ordinary siding; if they do not they run into the sand siding. The whole siding cost $1,750. In very dry weather the sand has to be moistened, but frost does not impair its efficiency.



ENG. NEWS.

Cross Section of Sand Catch Siding at Dresden, Saxony.

Up to the end of 1895 it had been tested only by a few stray engines, but on Dec. 21, 1895, a freight train of 20 cars, weighing 417 tons, and a locomotive and tender weighing 60 tons, dashed into the sand siding and came to a full stop within 81 ft. of the end of the siding. There was a delay of 24 minutes, but no damage was done to the rolling stock or to the track. The speed of the train was claimed to be 25 miles per hour; but computations show that it must have been much greater.

Mr. Kopecke, of the Board of Finance, of Saxony, in suggesting sand sidings, describes the method of construction and theory of operation, as follows: The general arrangement is shown in the cut. Switch points connect the siding with the main line; there is no crossing, and the auxiliary or sand rails rest upon the same cross ties as the main rails, but gradually dip deeper into the sand, until there is from 2 to 3 ins. of sand over them. This sand is held in position either by wooden longitudinals, or by sheet-iron flanges. At the further end of the switch the sand-rails rejoin the main line.

The strong braking effect experienced by running into such a siding is explained as follows by Mr. Kopecke, on the basis of theory and experiment: With a sand layer of uniform thickness the force, at the first impact, would be $P \text{ max.} = \frac{q\,f\,l}{4}$; in which q = average load per axle, about 8 tons; l = length of the train in units of average distance between axles, about 11½ ft., and f = the sand resistance, which was found to be 0.0625, allowing 0.005 for the resistance of the rails. The maximum pressure upon the buffers will be at the middle part of the train; and for heavy trains it will be better to increase the sand resistance gradually by spreading the sand in a wedge-shaped layer.

Mr. Kopecke then says that the resistance on a sand switch of length a, figured in the above units, would be $\frac{x}{a} f$, at a distance of x from the beginning of the switch; hence the maximum buffer pressure would be $\frac{q\,f\,l^2}{8\,a}$. For 150 axles and f = 0.0625, $a = 175.75 \frac{q}{P}$. If the greatest buffer pressure is equal to the average load per axle, the length a, of the sand switch, would equal 175.75 units, here taken at 11½ ft. each. This gives a sand switch of considerable length; but also of moderate cost; and experience proves that no damage to the rolling stock need be feared. Mr. Kopecke mentions 13 trials of sand switches with trains of varying length, empty and loaded, and running with speeds of from 12 to 54 ft. per second. For some few of these experiments the sand resistance f was found to be as follows:

Cars.	Speed, meters per second.	f.
Two empty	3.750	0.088
Four "	4.170	0.083
Eight "	5.882	0.0664
Ten loaded	7.692	0.0534
Ten " three empty	8.823	0.0675

THE WEIGHT OF GREEN LOGS IN PROPORTION TO THEIR TIMBER CONTENTS.

Through the courtesy of the Murphy Lumber Co., of Green Bay, Mich., we are enabled to give the results of some recent experiments to determine the weight of green lumber. This work was done in order to get at the freight rates to be charged per thousand ft. B. M. for hauling green logs, and is of interest to both railway managers and to lumbermen. It should be mentioned, however, that the percentage of waste in small logs, as compared with large ones, is so great that it is practically impossible to obtain an accurate common factor of average weight per foot B. M., by which the entire weight can be obtained by multiplying the number of feet scaled by this factor. The following table is, therefore, presented as the result of separate careful measurements, and for general information only.

The timber here weighed was in the form of logs. The weighing was done on the cars on track scales, and the cars were then weighed empty; or else the logs themselves were weighed on platform scales. The logs were scaled on the cars by Merchantable scale, Scribner's rules.

Experiments to Determine the Weight of Green Logs per ft. B. M.

Quantity.	Kind of wood (all logs).	Ave. w't per ft. B.M., lbs.	Remarks.
20 cars	White pine	8.04	Cut Jan., '96; large deduct'ns for shake, rot, etc.; tr'k scales.
11 "	" "	8.80	Green and dry mixed; track scales tested.
12 "	" "	8.6 to 9.4	Cut Jan., '96; sound, medium size, mostly green; trk scales.
1 car	" "	8.30	Track scales.
3 logs	" "	10.80	Platform scales.
1 log	" "	8.50	Platform scales; log partially imperfect.
5 logs	Norway pine	9.25	Platform scales; 10 to 17 ins. at butt; cut Jan., 1896.
12 cars	Michigan white pine	9.50	Track scales; cut Feb., 1896.
7 logs	Yellow birch	12.95	Cut Feb., 1896; platform scales; very green, not good.
6 "	Ash	8.62	Platform scales.
7 "	"Pig" Norway	12.21	Platform scales.
76,895 ft. B.M.	White pine logs	7.80	Separately on platform scales; part carloads on tr'k scales.
11 cars	"	8.80	Scaled at Marinette by railway scaler.
5 logs	"	5.8 to 10.8	Platform scales; scaled at Marinette.
12 "	" very heavy sap pine	9.30	Cut Jan., '96; 16 ft. long; 9 to 20 ins. diam.; pltfrm scales.
7 "	Yellow birch	12.50	Separately on platform scales; 12 to 21 ins. diameter.
10 cars	White pine	7.68 to 11.50	Cut Jan., 1896; track scales, tested.
1 car	Maple, birch, elm and basswood.	12.60	Cut Jan., 1896; track scales, tested.
1 "	Birch and basswood	13.10	
1 "	Basswood	11.10	
1 "	W. pine, oak, maple, birch, b'sw'd	11.80	
9 cars	Basswood	11.40	Cut Jan., 1896; track scales, tested.
10 "	White pine	8.50	Cut Jan., 1896; track scales, tested.

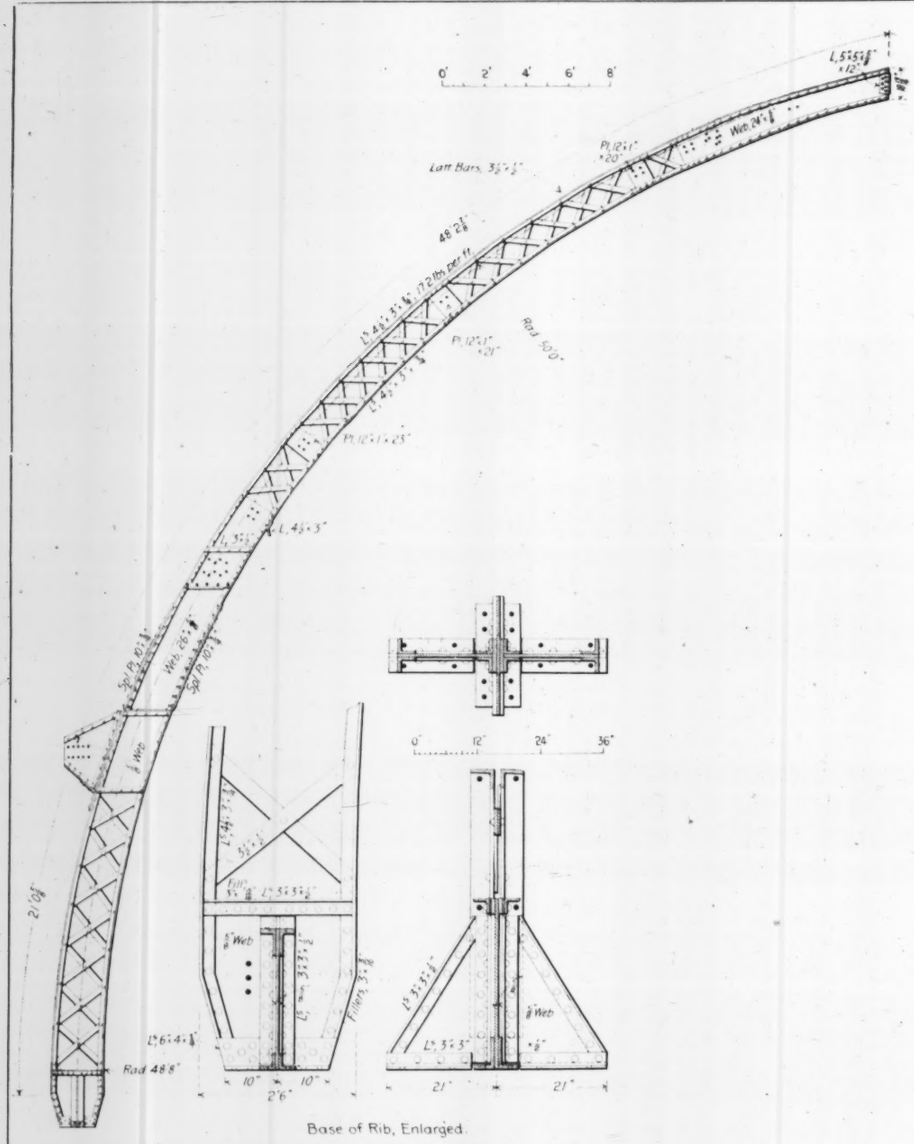
BRITISH SHIPBUILDING for 1897 accounts for the launch of 791 vessels, aggregating 1,066,619 gross tons, says the English "Fair Play." The largest output of any single firm was that of Harland & Wolff, with 11 vessels of 84,240 tons in all. The largest vessels launched were the twin-screw "Cymbric," of the White Star line, of 12,340 gross tons; the "Brasilia," of 11,100 tons, and the "Briton," of 10,248 tons, all built by Harland & Wolff. The output from private yards in 1896 was 743 vessels of 1,257,339 gross tons; in 1895, it was 630 vessels of 1,020,708 gross tons; in 1894, it was 622 vessels of 1,073,[illegible] gross tons, and 545 vessels in 1893 and 690 in 1892. The engineers' strike is charged with shortening the product for 1897, as yards were closed because engines were not ready for the hulls.

STEEL DOMES OF THE PARROTT BUILDING AND THE CITY HALL AT SAN FRANCISCO, CAL.

(With two-page engraving.)

The Parrott Building on Market St., San Francisco, Cal., is a combination of a department store (the "Emporium"), and an office building of steel skeleton construction, and was completed in July, 1896. The site is 381 × 275 ft., and the store itself, 350 × 275 ft., is obstructed only by columns, there being no interior walls, but only the store fixtures and partitions. Above the main floor is a gallery floor, also used for store purposes. The basement has a clear height of 14 ft. 1½ ins.; the main floor, 24 ft.; and the gallery floor, 19 ft. 6 ins. In the center is a rotunda 100 ft. in diameter, and about 50 ft. high to the springing of the dome, this dome being 100 ft. diameter, with its top 100 ft. above the main floor. Above the second or gallery floor the building is carried up in the form of a hollow square, with five stories above the gallery floor in the main part and three in the wings and rear. These floors are for show rooms and offices, while the fifth floor contains the court room and offices for the Supreme Court of California. The foundations are of concrete, there being 302 concrete piers for the columns, from 9 to 22 ft. square, and all 8 ft. deep below the basement level. The retaining walls and exterior piers, also of concrete, extend 15 ft. above the basement, and concrete blocks form the foundations for the engines and machinery for the electric light plant, elevators, etc. The Market St. front is of Oregon sandstone, the architectural design being in the classical style, and the side and rear are of brick, the rear, however, being finished with molded cornices, caps, string courses, etc., all of cement. The interior finish is very handsome and elaborate, but with this we need not concern ourselves. The structural work consists of steel columns, with steel plate girders and I-beams for the floor framing, heavy plate girders supporting the masonry over the wide store-front windows, and also supporting the interior walls above the level of the gallery floor. The general style of the skeleton construction is shown in Fig. 1, which also shows the base ring of the 100-ft. dome and the derricks used in handling the material.

The most interesting feature of the construction, from an engineering point of view, is the structural design of the dome, now concealed by elaborate decorative work and decorated glass. The dome is 100 ft. in diameter at the base, 50 ft. 11¾ ins. high, with a cap ring of 22 ft. 6 ins. diameter, above which extends a lantern 16 ft. high. The



Base of Rib, Enlarged.

FIG. 4. DETAILS OF MAIN RIBS.

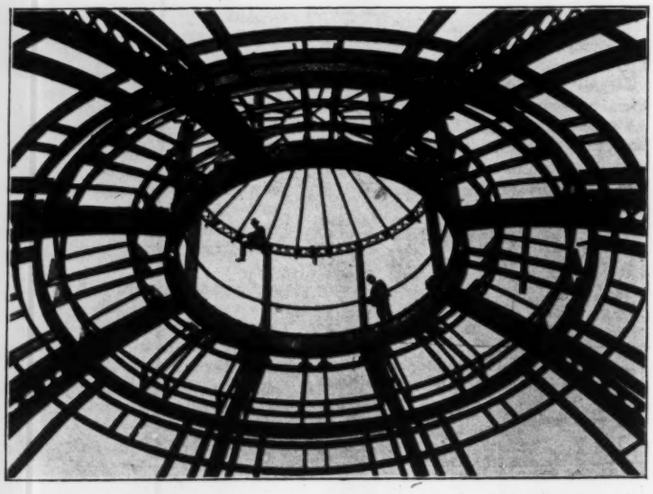
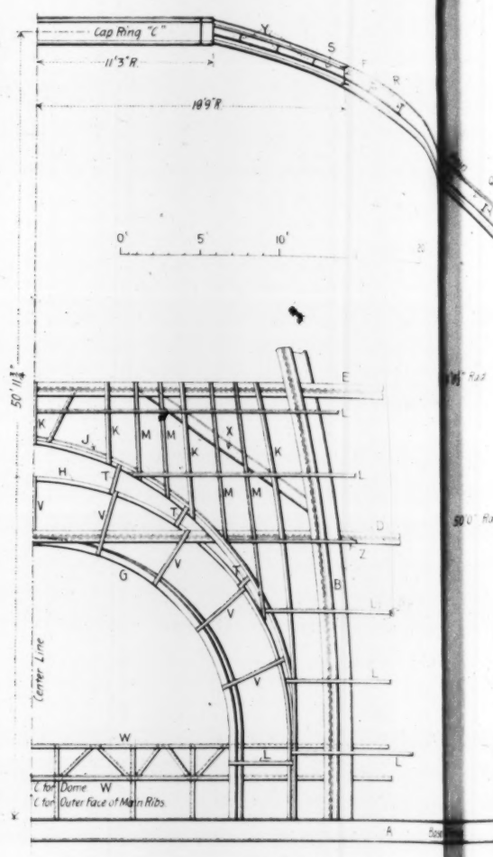
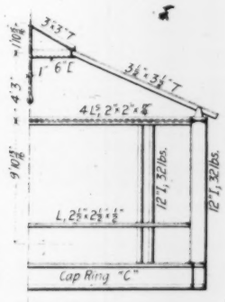


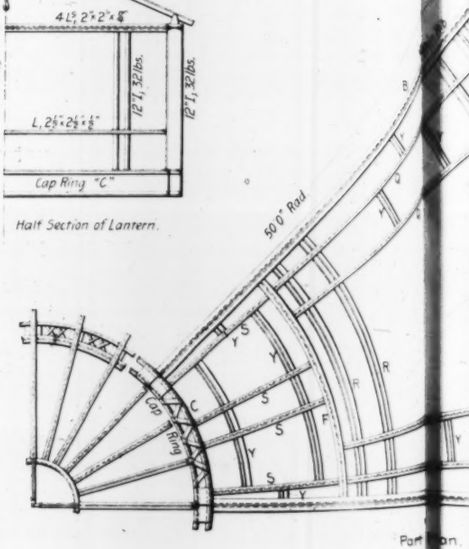
FIG. 5. VIEW OF FRAMING OF DOME.



Half Sectional Elevation.



Half Section of Lantern.



Part Plan.

FIG. 2. DETAILS OF TH STEE

STEEL
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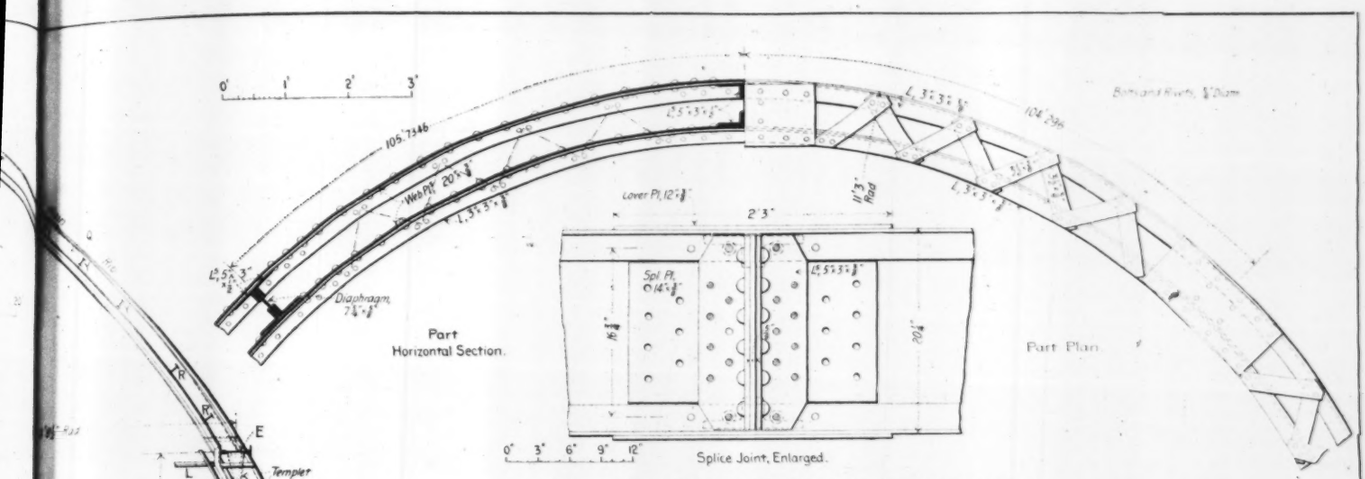


FIG. 3. DETAILS OF CAP RING FOR DOME.

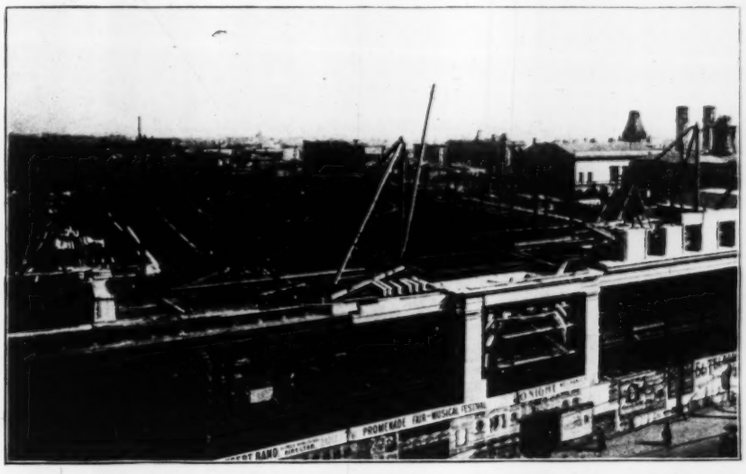
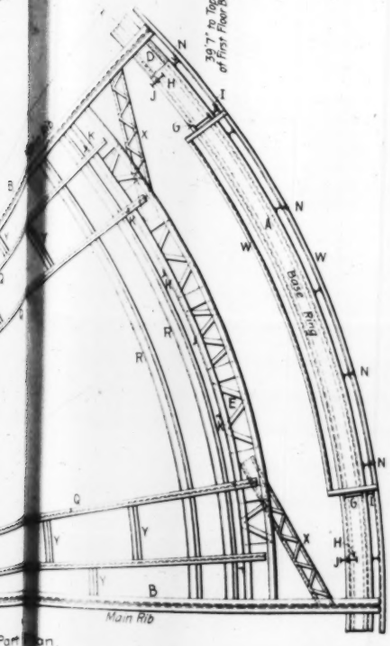


FIG. 1. STRUCTURAL FRAMEWORK, SHOWING BASE RING OF 100-FT. DOME.



Part Plan.
THE STEEL DOME.

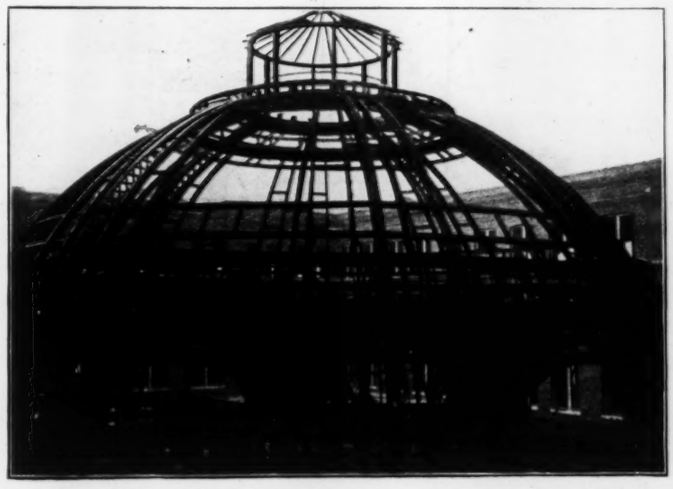


FIG. 6. EXTERIOR VIEW, SHOWING FRAMING OF GROINED ARCHES.

STEEL DOME OF THE PARROTT BUILDING, SAN FRANCISCO, CAL.
Designed and Built by the Pacific Rolling Mill Co., San Francisco.

surface of the dome is curved to a radius of 50 ft., and this surface is broken by large groined arches over the naves which enter the rotunda. The general arrangement of the framing is clearly shown by Fig. 2, and the composition of the various members is given below, the letters referring to the reference letters in Fig. 2, and this list will enable any structural engineer to follow out clearly the details of the design:

(A) Base ring, 100 ft. diameter; circular horizontal girder at third floor level; two 15-in. I-beams, 50 lbs. per ft.; top and bottom plates, ⅝ × 18 ins.

(B) Main ribs (8), radius, 50 ft.; lattice girders, 2 ft. 6 ins. deep at the bottom, 18 ins. at top; four angles, ¾ × 3 × 4 ins.; lattice bars, ½ × 3½ ins.

(C) Cap ring, against which the main ribs abut, 22 ft. 6 ins. diameter; four angles, ⅝ × 3 × 3 ins.; two plates, ⅜ × 20 ins.; top and bottom lattice.

(D) Circular horizontal lattice girder, 100 ft. diameter; four angles, ⅝ × 4 × 4 ins.; lattice bars, ½ × 3½ ins.

(E) Circular horizontal lattice grider, 87 ft. 5 ins. diameter, forming main support of glass; four angles, 9-16 × 5 × 5 ins.; lattice bars, ⅝ × 4 ins.

(F) Circular horizontal beam girder, 39 ft. 6 ins. diameter, forming secondary support of glass, 15-in. I-beam, 50 lbs.

(G) Circular vertical beam, 15-in. I-beam, 41 lbs., forming inside groined arch of 12 ft. 8 15-16 ins. radius.

(H) Circular vertical beam (concentric with G), 6-in. I-beam, 16 lbs., forming outside arch of 16 ft. 8 15-16 ins. radius.

(I) Circular vertical beam, forming arch of 13 ft. 0¾ ins. radius at outer wall of dome; 6-in. I-beam, 16 lbs.

(J) Circular member, forming groined arch, 6-in. I-beam, 16 lbs.

(K) Vertical furring members, riveted to J and E; angles, 3 × 3 ins., 6 lbs.

(L) Horizontal furring members, riveted to J and K; angles, ¼ × 2½ × 2½ ins.

(M) Vertical furring members, secured to L and J to receive wire lath; angles, 1½ × 1 ins., 8 lbs.; punched with ⅜-in. holes, 16 ins. apart.

(N) Vertical members, forming the outside wall of dome; 6-in. I-beam, 13 lbs.

(O) Horizontal members, forming the framing of outside wall; angles, 5-16 × 3 × 3 ins.; ½-in. holes, 24 ins. apart.

(P) Diagonal bracing for N and K; angles, ½ × 2½ × 2½ ins.

(Q) Circular vertical members, forming secondary ribs of dome; 12-in. I-beam, 32 lbs.

(R) Circular horizontal members, carrying the glass; numbers 1 to 80 are 8-in. I-beams, 22 lbs.; numbers 81 to 160 are 8-in. I-beams, 18 lbs.

(S) Circular vertical members, carrying glass; 6-in. I-beams, 13 lbs.

(T) Diagonal members, uniting H and J; angles, 5-16 × 3 × 3 ins.

(U) Vertical members, forming pier; angles, ½ × 4 × 4 ins.

(V) Radial members, uniting G and H; angles, ½ × 2½ × 2½ ins.

(W) Circular members, forming inside sill; angles, 5-16 × 3 × 3 ins.

(X) Diagonal struts, supporting overhang of E; two 8-in. channels, 11 lbs., with lattice bars ½ × 3 ins.

(Y) Circular horizontal members, carrying glass; 6-in. I-beam, 13 lbs.

(Z) Vertical members, carrying outer rib covering; 4-in. I-beam, 7½ lbs.

In Fig. 3 are shown some details of the cap ring, including the splices of the four sections in which it was built, while Fig. 4 shows some details of the main ribs, of which there are eight. These ribs are 18 13-16 ins. wide at the base, and 20 ins. deep at the upper end, the web being partly plate and partly latticed. The radius is 50 ft. on the center line, 51 ft. 3 ins. on the outer face, and 48 ft. 9 ins. on the inner face. Fig. 5 is an excellent view of the dome framing from beneath, while Fig. 6 is an outside view, showing the framing of the groined arches. The amount of structural ironwork in the dome is about 400 tons.

The architects for the building were Messrs. Pissis & Moore, of San Francisco. The structural work was designed, manufactured and erected by the Pacific Rolling Mill Co., of San Francisco, and we are indebted to Mr. Patrick Noble, general manager of that company, for photographs and blue prints of the work.

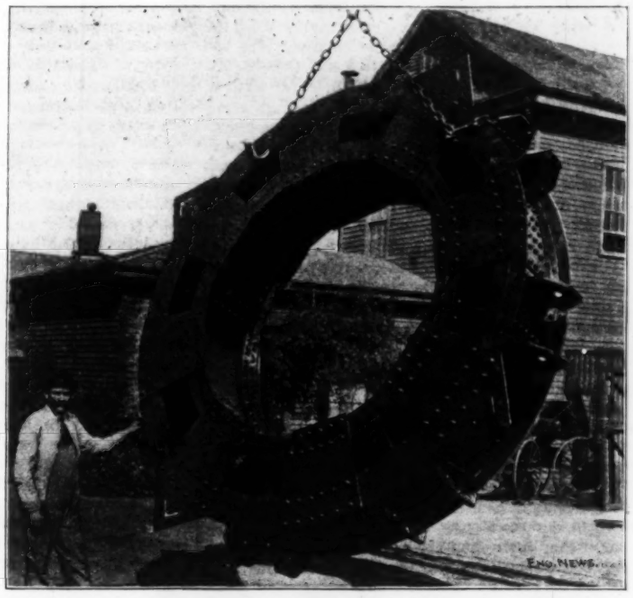


FIG. 7.—CAP RING OF DOME OF CITY HALL AT SAN FRANCISCO, CAL., Pacific Rolling Mill Co., Engineers and Contractors.

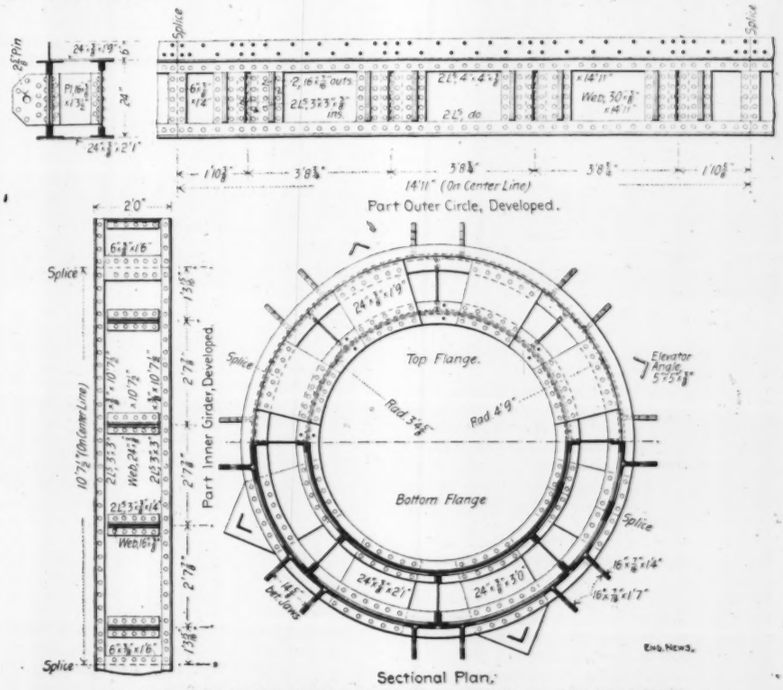


FIG. 8.—DETAILS OF CAP RING OF DOME OF CITY HALL, SAN FRANCISCO.

Fig. 8 is an outside view, showing the framing of the groined arches. The amount of structural ironwork in the dome is about 400 tons.

The architects for the building were Messrs. Pissis & Moore, of San Francisco. The structural work was designed, manufactured and erected by the Pacific Rolling Mill Co., of San Francisco, and we are indebted to Mr. Patrick Noble, general manager of that company, for photographs and blue prints of the work.

Among the other contractors were the following; Cement (20,000 barrels of Star and Josson brands), W. R. Grace & Co.; concrete, George Goodman; granite (including a slab 24 ft. 7 ins. long, 6 ft. 6 ins. wide and 12 ins. thick, for the main entrance floor), Raymond Granite Co.; Oregon gray sandstone for main front, Pioneer Sandstone Co., Yaquina Bay, Ore.; brick masonry, Richardson & Gale; stone masonry and carving, John P. McGilvray; hollow terra cotta tile flooring and fireproofing, Gladding, McBean & Co.

The Pacific Rolling Mill also designed and built the structural framework for the new steel dome on the City Hall at San Francisco, and Mr. Frank T. Shea, of the firm of Shea & Shea, of San Francisco, was the architect for the dome and rotunda, the final completion of which was celebrated with some ceremony on July 12, 1897. The dome is 67 ft. 5 ins. diameter at the base, and 9 ft. 6 ins. diameter at the cap, with a rise of 43 ft. 9 ins. from springing line to cap. The ornamental metal work was supplied by the San Francisco Novelty & Plating Works; the marble for steps and decorative work by Wm. H. McCormick; the carpentry work, by James F. Leahy, and the ornamental glass work, by the Pacific American Decoration Co. This last contract was for 4,000 sq. ft. of glass at a contract price of about $22,000.

This dome is 67 ft. 5 ins. diameter at the base and 9 ft. 6 ins. diameter at the cap, with a rise of 43 ft. 9 ins. from springing line to cap. The cap ring, shown in Figs. 7 and 8, has an inside diameter of 6 ft. 9½ ins., and an outside diameter of 9 ft. 6 ins. It consists of two concentric plate girders, 24 ins. deep, rigidly connected by 16 vertical diaphragms and by top and bottom plates, the bottom plates extending beyond the outer girder and being slotted for the angle iron guides of the elevators. The ring weighs complete about 3½ tons, and was made in two sections, which were spliced and finished up complete in the shops. The dome has eight main ribs, and these are attached to the cap ring by pin connections, as shown by Fig. 7, instead of by riveted connections as in the dome of the Parrott Building. The pins are 2⅝ ins. diameter. The details of construction are shown by Fig. 8, and the cap ring is built up as follows;

Cap ring for City Hall Dome at San Francisco, Cal.

Outer girder:
- 2 plates.. .. .. .

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post Office as Second-Class Matter.

Published every Thursday

at St. Paul Building, 220 Broadway, New York, by

THE ENGINEERING NEWS PUBLISHING COMPANY.

D. McN. STAUFFER, Vice-President, CHARLES WHITING BAKER, Secretary, } - - - EDITORS.

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PUBLICATION OFFICE, ST. PAUL BUILDING, NEW YORK.
WESTERN OFFICE, MONADNOCK BLOCK, CHICAGO.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00. To all other countries in the Postal Union: Regular Edition, One Year, $7.60 (31 shillings); Thin Paper Edition, One Year, $6.31 (26 shillings). SINGLE COPIES of any number in current year, 15 cents.

Mailing addresses may be changed at will by sending both old and new address. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 326 means that subscription is paid to the 32d week (that is the issue of Aug. 12) of the year 1897; the change of these figures is the only receipt sent, unless by special request.

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It has been generally agreed for years that forests bear a very important relation to the flow of streams, and thus to all questions of water supply for city purposes, irrigation and power. The exact character of this relation has been a fruitful subject for discussion. Some hold that forests increase the total runoff of streams, besides giving rise to a more equal distribution of stream flow throughout the year. Others contend that forest areas perform only the last of these two services, having no effect upon total yield. Still others give forests credit for conserving the water supply of small areas or local districts, while having no effect upon large areas.

In other columns of this issue will be found two papers on this subject, in which diametrically opposing ideas are advanced. Mr. C. C. Vermeule holds that not forests, but temperatures, are the controlling factor in runoff, while Mr. George W. Rafter, M. Am. Soc. C. E., believes that forests act the main part, although admitting that temperature has a minor effect. Each author bases his conclusions on records of rainfall, runoff and temperature, but the records are mostly for different drainage areas, and where not so are for different periods. The records used by each author are in many instances either for short periods or incomplete. On this account Mr. Vermeule is perhaps at a disadvantage, not so much in the matter of records as in that he relies wholly upon his records, while Mr. Rafter takes into account certain results obtained by experiment and observation in fields which he believes to be allied closely to the main subject. Thus Mr. Vermeule says that he knows no more satisfactory way to study the subject than to consider total rainfall and total runoff, ignoring experiments on the subject of evaporation.

Obviously if we can obtain accurate records of rainfall and runoff, extending over a sufficiently long period, we need ask for nothing else in the study of a given drainage area, and if we can obtain a sufficiently large number of such records for a variety of conditions of forest and cultivated areas nothing else will be needed to enable us to draw generalizations regarding the effect of forest on stream flow. On the other hand, with a limited range of records, some of which are incomplete, it may be advantageous to make use of experimental results and carefully considered theory in drawing even broad generalizations. This is well illustrated by the two papers under discussion. Pursuing the same methods, but using different records, Mr. Vermeule reaches the conclusion that temperature is the main factor in runoff, as affected by evaporation, while Mr. Rafter comes to a contrary conclusion. Mr. Rafter, however, supplements his records by a general survey of the various factors which he believes enter into the case, as indicated by observation and theory. Mr. Vermeule, finding a close relation, in his figures, between temperature and runoff, and knowing that the latter is an important factor in evaporation, stops with the known and determinable elements in his problem, urging that the experiments commonly cited as bearing on the case were made under different conditions than those existing in nature. We shall rest content with having set forth the methods and conclusions of each author, without attempting to analyze their figures or make further comments on their methods. Those interested in the subject will do well to go back to the detailed figures and discussions of the two authors, as given in the public documents mentioned in connection with our abstract of their figures. There they will also find, in Mr. Rafter's reports, references to the literature of the subject.*

In conclusion, the most important practical point connected with this subject is that both Mr. Vermeule and Mr. Rafter, and engineers and meteorologists in general are agreed that forests play a most important part in the regimen of streams, equalizing their flow through the year, diminishing the amount of silt carried by streams and otherwise proving of value. These reasons alone are sufficient grounds for making a firm stand for forest preservation. If in addition it should ultimately be proven that forests increase the total yield of streams the importance of this work would be still further evident, while there still remain a variety of other reasons for carrying it on, the chief of which, and one in itself sufficient, is the fact that our forests should be preserved in order to maintain the timber supply of the country.

*Although presumably given by Mr. Rafter, we will cite, to make certain that they will not be overlooked by those wishing to make an exhaustive study, "The Influence of Forests on Rainfall," by Prof. Geo. F. Swain, in the journal of the New England Water-Works Association, and "Forest Influences," by B. E. Fernow, being Bulletin No. 7 of the Forestry Division, U. S. Department of Agriculture. In our issue of Sept. 20, 1894, there appeared an editorial on "The Protection of Forests."

The Naval Personnel Board, to which Secretary of the Navy Long several months ago delegated the task of straightening out the unseemly "line and staff" controversy, has submitted its conclusions in an interesting report written by Assistant Secretary of the Navy Theodore Roosevelt. Briefly summarized, the Board recommends: (1) That the line officers and engineers be amalgamated; (2) that when the number of officers to be promoted is so far in excess of the vacancies as to cause stagnation, the requisite number of vacancies shall be created by weeding out the men who are least fit to meet the requirements of modern naval duty, and (3), that the enlisted men aboard ship shall be given the same rewards in pensions and retirement for age that are enjoyed by their brethren who fight ashore, while the higher class of machinists are made warrant officers, to rank with the gunners and carpenters. In other words, both the line officer and the engineer officer, as they now exist, are to be done away with and a corps of officers who are both engineers and line officers is to be substituted in their place.

All things considered, this solution is perhaps the best that has yet been offered. The maintenance of discipline is absolutely essential; and in all the previous plans proposed for the betterment of the status of the Corps of Steam Engineers by giving them absolute rank, absolute control in the engine room, etc., there was room for some clash of authority. Under the proposed law the officer in charge of the engine room will have all the authority required over his subordinates, and will yet have fixed and well-understood relations with his brother officer in charge of the deck; and as the two stations would be interchangeable, one source of constant bickering would be permanently removed.

But will the general knowledge of engineering principles involved and the necessarily limited amount of practical experience gained by the future naval officer be sufficient to meet all the demands of modern naval conditions? We think not—unless the status of the sea mechanic is radically changed as well. A ship at sea, in the present time, is an intricate machine, far removed from the yard that launched it, and the men who designed and built it. It is filled with engines, boilers, dynamos, and machinery of all types, complicated in their structure and in their relation to each other. Fully to understand this mechanism and to keep it in a state of constant efficiency, ever ready for the fullest development of power, and to repair quickly and properly damages caused by weather or occurring in action, requires a higher class of mechanical training and longer period of practical experience than can be expected of the naval officer, who has not had a special training in mechanical engineering. The analogy between sails and engines, drawn by Mr. Roosevelt, is not quite so close as he seems to think. Nelson knew all about sails for the reason that his duty as a younger officer was handling sails; and the handling of a ship or of a fleet in the face of an enemy was then much easier than clawing off a lee shore, in stress of weather. In Nelson's day the chief tools of the fighting man and the sailor were also very much alike; the Jack Tars did the shooting after the Captain had placed the ship in the proper position. To-day the battle-ship may be transformed into a helpless, floating hulk, and its best batteries may be rendered practically useless by the bursting of a steam pipe, or the failure of some important machine. Sails shot away or a yard or mast crippled, might also temporarily interfere with the proper handling of the old frigate; but if the quarters were close enough fighting would go on as before, while repairs were being made. But future battles at sea will be matters of minutes, not hours; and success, or defeat, or absolute destruction may depend upon the speed and skill with which the damages are repaired.

We therefore say, that while the future officer may be sufficiently trained to understand the management of the engines upon which he depends, and may be competent to direct their movements, the conditions would also require that he be ably backed by men in the engine room who can quickly and efficiently carry these orders into effect. To secure sea mechanics of this type, the pay and rank must be high enough to attract them. The success of the proposed reform depends upon the manner in which this feature is carried out. Mr. Roosevelt finds room for the future line officer between this class of sea mechanics, rated as warrant officers, and the men who plan and build engines, detailed for this purpose from among those who show special aptitude for this service. But at sea, and in an extremity, due to warfare with an enemy or with the elements, the salvation of the vessel and all its crew may depend upon the mechanic in charge of the engines; and unless he be an exceptionally competent and reliable man, the system will be a failure.

WHAT SHALL NEW YORK DO WITH ITS CANALS?

In our issue of Dec. 23 we discussed the charges which have been brought against the New York state canal administration in connection with the announcement that the work of deepening the canals to 9 ft. will require about $16,000,000, or $7,000,000 in addition to the $9,000,000 appropriated by the legislature and approved by popular vote in November, 1895. In our last issue we published a full abstract of the detailed statement published by the State Engineer and the Superintendent of Public Works, setting forth the reasons why the cost of the work proves to be nearly double what was originally estimated.

We believe that engineers generally will appreciate the reasons that are offered for the inadequacy of the estimates which were presented to the Constitutional Convention of 1894. The idea is only too prevalent that an engineer should be competent to estimate accurately the cost of a work from his inner consciousness alone; the fact that it is necessary for an engineer to spend considerable time and money on surveys before he can prepare estimates of the cost of a work, is apt to be received with impatience. The engineer is

frequently informed, in such a case, that it is not an accurate estimate which is wanted, but only an approximate one. Then when he makes his approximate estimate (or rather his guess, for an engineer can only guess at the cost if he has to guess at the quantities and conditions), and it proves wide of the mark, the fact is cited as another proof that engineers' estimates are wholly unreliable as indications of the ultimate cost of a work.

We do not propose at this time, however, to discuss what has been done in the past, or who is to blame for the huge mistake in ascertaining the cost of the canal improvements. The important thing to consider is the present situation in which the state of New York finds itself, and the course which will be for its best interest to pursue.

The total cost of the Erie, Oswego, and Champlain canals to the state of New York has been in round numbers $61,000,000. The annual cost of operating and maintaining the canals of the state is in round numbers $750,000. The state derives no revenue whatever from the canals; all tolls upon them were abolished in 1880. The interest on the $9,000,000 of bonds already authorized for canal improvements amounts to $270,000 per annum; and, assuming that $7,000,000 more would be required to complete the deepening to 9 ft., the total operating expenses and interest charges with which the taxpayers of the state will be burdened on account of the canals will be $1,230,000.

As stated above, the state gets no return whatever for this expenditure save the indirect benefit due to the traffic which seeks these waterways.

Let us now review the various alternative courses which are open to the state at the present time. The first course, and one which we regret to say seems very likely to be followed, is to expend the rest of the $9,000,000 already raised, but refuse further appropriations. Under the New York constitution, in order to secure the $7,000,000 additional required to complete the 9 ft. depth improvement, it will be necessary for the legislature to pass a bill authorizing this expenditure, and this bill must then be approved by a popular vote in a state election. In the present condition of New York state politics it seems to us very doubtful whether either party in the legislature will care to assume the responsibility for saddling $7,000,000 additional debt upon the state. It appears even more doubtful, however, whether, if such a bill should pass the legislature, it would be approved by the people. In 1894 the amendment to the constitution providing for the improvement of the canals was opposed by a vote of 327,645, compared with 442,988 in its favor. In 1895, the $9,000,000 appropriation was approved with practical unanimity by the press of the state, and a vast amount of work was done to influence voters in its favor; yet, although it was carried, a very heavy vote was polled against it. Will the voters of New York who were told two years ago that $9,000,000 would deepen the canals to 9 ft., now give $7,000,000 more to complete the work? It appears to us more likely that they will call to remembrance the repeated promises which were made concerning the state capitol building at Albany, and refuse to spend another cent on canal improvement.

If they pursue this course, it needs no prophet to foresee the practical disappearance of canal traffic within a very short time. As many of our readers may recall, the decadence of canal traffic has been very rapid in the last few years.

In 1890, the canal tonnage was 5,246,102. In 1894 it fell to 3,882,560. In 1895, a further decline occurred to 3,467,848. In 1896 the showing was a little better, but the total was only 3,714,894. Figures for the present year are not at hand; but we believe the total will approximate to that of 1895. The falling-off in traffic is even more evident by the records of grain carriage. The total grain traffic of the canals for the past four seasons has been as follows:

Year.	Grain by canal, bushels.
1894	48,418,622
1895	20,064,613
1896	35,868,906
1897	23,848,621

At the same time, the railways which carry grain from the lakes to tidewater have been rapidly increasing their traffic, and are able to haul full train loads at a rate nearly or quite as low as the rates by canal. The railways have the great advantages in securing shipments, of rapid delivery, of full responsibility for loss and damage, and of arrangements with connecting lines whereby the shipper obtains through bills of lading without difficulty. The law which limits the capital of any corporation making use of the canal to $50,000 operates to prevent absolutely the development of the canal in accordance with modern methods of transportation and finance.

Under these conditions it is not to be wondered at that traffic on the canals is rapidly disappearing. The profits to the boatmen are so insignificant, and the chances of the total disappearance of profits in the near future are so great that the boatmen are abandoning the business; the old boats are rapidly becoming rotten and unseaworthy, and few or no new boats are built to take their place.

We need go no further to prove that to leave the canals as they are means such a falling-off in traffic that in a few years the people will no longer submit to the heavy annual appropriations required to maintain and operate the canals for the sake of the remnant of traffic that may still remain. In other words, if the canals are to be left with the improvements now under way upon them incomplete, a few years hence will see their total abandonment, and the loss to the state of the entire investment which has been made in them. Even if we do not take so extreme a view and suppose that the canals are still kept open, it is as certain as can be that unless the present improvement is completed the usefulness of the canal as an avenue of traffic is very near its end. A great deal has been said, and truly said, concerning the value of the canal as a regulator of railway rates; but its value in this field also is sure soon to disappear if traffic continues to fall off at the present rate.

Let us turn now to the second alternative open to the state—the completion of the present improvement to give a 9-ft. depth of water, and with high-level lift locks at certain points on the canal. The net result of this improvement was fully reviewed in our issue of Oct. 31, 1895. It will amount to increasing the capacity of the barges that use the canal to about 400 tons, as compared with the present barges of some 240 tons. It is estimated that this would decrease the cost of canal freights from Buffalo to New York as much as 1 ct. per bushel, and would facilitate the operation of through lines of barges between the Lake ports and the seaboard. If the alternative presented to the people of New York is either the abandonment of the canals in the near future, or a further expenditure of $7,000,000 to complete the improvements now under way, then we believe this expenditure ought to be made.

There is, however, another possible course open to the people of New York, and that is to turn over the Erie Canal to the United States government. As our readers will remember, the result of Major Symons' recent investigation of the problem of the cheapest system of water transportation from the Great Lakes to the seaboard, was that such a system would be obtained by the improvement of the Erie Canal to accommodate barges of 1,500 tons capacity. Of course, while the canal remains the property of the state of New York, the United States is barred from undertaking such a work. If, however, the canal were to be transferred from the state to Federal control, there is good reason to believe that its improvement on the lines recommended by Major Symonds could and would be carried out.

The United States now controls and maintains a great free waterway system extending from Duluth and Chicago to Buffalo, and from Albany to tidewater at New York. Why should it not undertake the maintenance and improvement of the remaining link in this system, from Buffalo to Albany? The fact is that the Erie Canal benefits the grain growers of the Northwest much more than it benefits the people of New York. A large part of New England is as much benefited by the Erie Canal as is the state of New York. The lake cities of Chicago, Milwaukee, Cleveland, and many others would derive more benefit from an improved Erie Canal than most of the cities of New York.

Let us see what the Erie Canal will cost the taxpayers of New York every year, if the additional $7,000,000 appropriation is voted. The account will stand about as follows:

Operating expenses and maintenance, say	$750,000
Interest on $9,000,000 bonds already authorized	270,000
Interest on $7,000,000 bonds additional	210,000
	$1,230,000

About a million and a quarter a year from the taxpayers of New York! But that is not all. It has been explicitly stated that in making this expenditure of $16,000,000 the work has been "pared down" as much as possible; there is other necessary work, rebuilding of structures, improved appliances for towing, handling boats in locks, etc., etc., which are pretty sure to be found necessary in the near future, even if the $7,000,000 additional is voted. Besides this, money must be raised to pay off the principal of the bonds, if they are not to be made a perpetual burden upon the state.

Now let us compare these figures of expenditure with the transportation actually effected by the canal. Suppose we take the canal traffic to be hoped for when the 9-ft. improvement is completed at 5,000,000 tons per annum, and estimate 200 miles as the average haul per ton on the canal. We then have a total of 1,000,000,000 ton-miles of transportation furnished. But the annual cost of the canal to the taxpayers of the state, we have seen above, is about $1,250,000; hence the taxpayers of the state will have to pay about 1¼ mills per ton mile for all the freight on the canals. The present canal freight rate averages about 3 cts. per bushel from Buffalo to New York, or about 1 1-5 mills per ton mile. In other words, if the traffic on the canals when deepened to 9 ft. averages 5,000,000 tons per annum, the taxpayers of the state will be paying about as much in the cost of keeping up the canal and the fixed charges upon it, as the boatmen receive for freight at the present time.

These figures certainly furnish food for thought, by the taxpayers of New York. They seem to us to prove conclusively that if the Erie Canal is to be worth what it has cost, and worth the valuable real estate which it occupies, if it is to compensate the public for the obstruction which it creates in roads, railways and streets, and the draft that it makes upon the water supplies of the state, it must in some way be made to carry a traffic of much greater volume than it has had at any time in its history.

But it is, we take it, out of the question for the state of New York to undertake any more radical improvement in this canal than that which it has now under way. The most it can do (and, as we have said above, it is doubtful whether it will do even that), is to complete the work it has already begun. The United States, on the other hand, could, and we believe, would, undertake the radical enlargement of the canal, if the state of New York were to signify its willingness to turn it over on condition that at least the present improvements should be completed.

There is a vast amount of public sentiment all through the Northwest and in the cities upon the Great Lakes which favors the government construction of a waterway to the ocean. The "ship canal" idea, however, is rapidly waning in popularity, and it is coming to be generally understood, that a waterway which will be at once financially practicable, and a success as a medium of cheap transportation, must be planned on more modest lines than the much-talked-of "highway to the Great Lakes for ocean steamers." The sections which would be benefited by an Erie Canal improved to accommodate barges of 1,000 to 1,500 tons would include most of New England, New York and New Jersey, and in the west the greater part of Ohio, Indiana, Illinois, Michigan, Wisconsin, Iowa, Minnesota and the Dakotas. It is as reasonable for Congress to improve the Erie Canal for the benefit of these states as it is to improve the Mississippi or the Ohio, to operate the canal and locks at Sault Ste. Marie, to build the Hennepin canal, or to carry on any other of the numerous works which it undertakes for the improvement of waterways.

We are aware that the present state constitu-

tion of New York prohibits the state parting with its canals; but we believe the taxpayers of the state would so welcome the prospect of relief from the burden of canal maintenance that an amendment to the constitution permitting their transfer to the United States would meet little opposition. It may be argued that the state would run the risk that the Federal government would neglect or abandon or mismanage the canals; but it does not appear to us that the risk of the canals suffering in this way would be any greater, to say the least, than would obtain if they remained under state control. On the other hand, if the government would undertake the radical enlargement of the canals, it would mean a benefit to the state which it never could secure if the canals were to remain under state control.

We reviewed in our issue of Dec. 23, the report which has just been made public respecting the proposed canal from Lake Erie to the Ohio River, at Pittsburg. It is proposed to make this a barge canal, about 15 ft. in depth, accommodating vessels of about 1,500 tons, or not greatly different from the capacity of the waterway proposed by Major Symons for the enlarged Erie Canal. This project is certain to come up in Congress at the present session, and the friends of an improved Erie Canal will do well to see that the claims of their enterprise are considered at the same time.

As our readers are aware, Engineering News is exceedingly conservative in its discussion of the various canal enterprises which are from time to time brought forward. It appears to us, however, that the projects for free waterways of 12 to 15 ft. depth, accommodating vessels of 1,000 to 2,000 tons, and connecting the Great Lakes with the Ohio at Pittsburg, and with the Hudson at Albany, have much to recommend them to the favorable consideration of Congress. Besides the traffic which each of these waterways would be especially designed to secure, it is worth pointing out that the two together would furnish a cheap water-route from the iron mills of Western Pennsylvania to the seaboard, and would thus assist their competition in the world's export trade which is at the present time a source of national pride.

LETTERS TO THE EDITOR.

Fast Records In Hydrographic Surveying.

Sir: There have been two remarkable records made in this district in the line of hydrographic surveying, and thinking your readers might be interested, I concluded to give them to you. It is generally supposed that a government job is a "soft snap," but these two records of long hours and fatiguing work will show that they are not always as soft as they might be.

The first record was made by the writer, and consisted of 12½ hours of continuous work at the instruments for himself and party. The work comprised soundings taken from a small steamboat and located by two transitmen on triangulation stations on shore at given signal from the chief of party on the steamer. These signals were given every minute. Work began at the instrument at 6 a. m.—that is, the first signal fell at that time, involving about two hours work previous to that in getting all of the party into position ready for work. The last signal fell at 6.30 p. m., making 12½ hours actual work at the instruments, with no stop for lunch except such as the men could catch between the stopping of one line of soundings and the starting of another.

During this interval, 526 signals were located and 3,150 soundings were taken.

The second record is a still heavier piece of work, and was made with the same steamer and in the same manner. In this case the first signal fell at 5.30 a. m., and the last at 7 p. m., making 13½ hours actual work. There were located 552 signals and 1,623 soundings were taken, the sounding being less in number because this work was done in deep water and the former in shoal water. This last piece of work was done by Marion Twiggs. If any of your readers have anything better than this record the writer would be pleased to hear about it.

Yours respectfully,
A. S. Cooper,
U. S. Asst. Engr.

Savannah, Ga., Dec. 22, 1897.

(The record above given is certainly a most creditable one. The only account of more rapid work in sounding that has ever come to our notice was sent us some time ago; and it sounded so apocryphal that we endeavored to verify it. While we have been unable to obtain proof of its correctness, the scheme is entertaining enough to be published, whether it was ever tried or not. According to this story, an engineer at Augusta, Ga., wanted to locate the boat channel in the Savannah River. He secured ten negroes and painted their backs and legs with horizontal lines in white, representing feet and half-feet. Small numerals were placed opposite the foot marks, and the men were numbered from 1 to 10, with large figures painted between the shoulders. They were then spaced 20 ft. apart in a line across the river, holding to two 100-ft. surveyor's chains, and in this order waded down the river. The engineer followed close behind in a skiff and recorded the depth of each man at regular intervals. In this manner a distance of 10 to 12 miles is claimed to have been covered in a day. So far as we can learn, this method of sounding is not patented, and any engineer located in a climate and among a population which would make it practicable, is at liberty to try it.—Ed.)

Concerning Fogs in Electric Railway Tunnels.

Sir: Your interesting and pertinent discussion of "Fogs in Tunnels and Elsewhere," printed under date of Dec. 30, 1897, will serve importantly if thereby railroad operators and other competent observers are induced to inform your readers whether, in their experience, fogs are likely or not to obscure vision within a tunnel; and it is to be hoped that such will communicate freely.

The discussion continued in the article mentioned, began with an editorial in the "Evening Post," printed Nov. 22, in which it was said:

A good many thousands of our citizens had an "object lesson" in rapid transit this morning in the annoying delays and discomfort caused by the fog. If we had an underground system a fog would have no effect whatever upon the movement of trains. Like snow and ice, it would be eliminated entirely from the transit problem.

In a letter to this newspaper your correspondent cited the above paragraph and inquired:

Is the writer sure that fogs may not affect the running of underground trains? With certain temperature and other atmospheric conditions favorable, a fog in a tunnel may be denser and more impenetrable to vision than at the same time it is on the surface.

You will note the reservation and surely will not contend against it.

A candid man, earnest and vigilant in the acquisition of truth, once remarked: "Next to knowing that I am right, I am pleased to know that I am wrong; for then correction may be made and error avoided." This is the attitude of receptive searchers for knowledge—without pride of opinion, anxious to be taught. Need I say that I am an humble member of this school of learners?

In the article referred to it is insinuated that the undersigned is a reader of "The Sun," and therefore influenced by its continued opposition to the underground schemes. This may be so, but is not pertinent. The arguments of one journal for or against a public measure receive greater approval than do opposing arguments of other journals simply because of their superior weight. In the court of popular opinion the decision of the masses is generally correct; if not at first, surely in time and before final conclusion.

Trusting you will pursue the subject under discussion to a definite and fixed conclusion, without further reference to assumed prejudice or standing of the advocates heard, I am,

Yours truly,
G. Leverich.

Brooklyn, N. Y., Jan. 3, 1898.

(Mr. Leverich's candid acceptance of the evidence presented in our last issue is commendable, but we do not quite understand his statement that further evidence is needed to bring the subject under discussion "to a definite and fixed conclusion." If it were needed, where is it to be found? Mr. Leverich will pardon us for restating the problem in its simplest terms:

The "Evening Post" said: "If we had an underground system, a fog would have no effect whatever upon the movement of trains." It meant by this an underground system, operated by electric traction, of course, for no other underground system has been seriously proposed for city railways for many years.

Mr. Leverich said in reply: "With certain temperature and other atmospheric conditions favorable, a fog in a tunnel may be denser and more impenetrable to vision than at the same time it is on the surface." Manifestly he is talking of the practical problem as presented by the New York Rapid Transit Ry. here, and of the conditions which would obtain in its tunnel. Now, will Mr. Leverich please state under what meteorological conditions, such as might occur in such a tunnel as that of the New York Rapid Transit Ry.; does he think the fog would be "denser and more impenetrable to vision" than on the surface?

As for Mr. Leverich's idea that the experience of "railroad operators and other competent observers" needs to be cited to settle this question, we are not aware of a single tunnel anywhere in the world which is a perfect parallel to what the New York Rapid Transit tunnel would be, except the Boston subway. If Mr. Leverich knows of any other, we shall be pleased to hear of it.—Ed.)

THE EOPHONE: A DEVICE FOR LOCATING THE DIRECTION OF A SOUND.

Aside from rare cases of fire the modern ship, when well manned and equipped, has few dangers to fear, except those of collision or of running aground in thick and foggy weather. The mere action of the wind and waves is responsible for but few disasters to vessels. At present the only safe guards against the danger of fogs are sounds made on board ship by bells and whistles, and by steam whistles and sirens and bells placed on buoys, light ships or on dangerous parts of the shore. The efficiency of these sounds to prevent accident depends entirely upon the ability of the pilot to hear them distinctly and to locate accurately their source, or the direction from which they come. This is often a difficult thing to do with the unaided ear.

The eophone, which we illustrate in the accompanying sketch, is a device designed to aid the ear in locating the direction from which a sound comes. This instrument is the invention of Mr. Della Torre, of Baltimore, Md., and the principle upon which its operation depends is that of the acoustic shadow. As will be seen from the illustration, two funnel shaped sound receivers are separated by a vertical vane. The sound waves when they strike perpendicularly upon one side of this vane act very slightly upon the opposite side, because this latter side is in the acoustic shadow. It follows, therefore, that one receiver catches practically all the sound waves and the other none of them; that is, since the receivers are connected by tubes with the opposite ears of the pilot, the sound is heard in one ear only. It further follows, when the sound is heard equally loud in both ears, that the vane is pointing in the direction from which it comes.

The Eophone; A Device for Locating the Direction of Sound on Shipboard.
Invented by Della Torre, Baltimore, Md. Manufactured by The Eophone Co., New York, N. Y.

In operation the pilot, when a sound, say for example a ship's bell, is heard, turns the vane until it is heard in one ear only, and notes the indication of the position on the dumb compass just above the hand wheel. This gives him the general directions from which the sound comes. He then turns the vane until the sound is heard in the opposite ear only, and again observes the pointer. Between these two indications of the pointer should be the point from which the sound comes. The operator, therefore, manipulates the

vane until the sound is heard equally loud in both ears, when, of course, the vane, and therefore the pointer, indicate closely the source of the sound. This being obtained, the pilot can take such precautions as are necessary to avoid danger.

The eophone is now in use on vessels of the Canada, Atlantic & Plant, Old Dominion, and other lines of coast boats; on the American transatlantic lines, and also on vessels of the U. S. Navy and Revenue Service. According to letters published by the promoters of the eophone the instrument has given universal satisfaction on all of these vessels. The committee of officers of the U. S. warship "Indiana," who tested the eophone, reported as follows:

> Various whistles and bells were easily and accurately located with this instrument, while steaming at a speed varying from five to eleven knots per hour, the instrument being manipulated by several members of the Board, some of whom had had no previous experience with it.
>
> The results tend to show that the instrument will prove of great value in accomplishing that for which it is designed; the experiments made indicate that an observer, with but little practice in the use of the eophone, can locate very nearly the direction of sound. Upon first trial one will, perhaps, be in doubt as to whether or not he has arrived at the proper angle showing the location of the sound, but with repeated tests it will be shown that the instrument points fair or accurately.

The eophone is manufactured and sold by the Eophone Co., Bowling Green, Broadway, N. Y., of which Mr. Lewis Nixon is President and Mr. Wm. McAdoo is Vice-President and Counsel. We are indebted to Mr. McAdoo for the information from which this description has been prepared.

AN ENGLISH FOUR-CYLINDER COMPOUND LOCOMOTIVE WITH A TWO-COMPARTMENT SMOKE BOX.

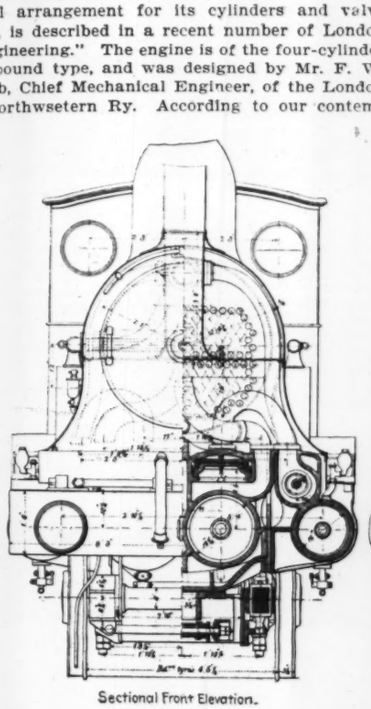
An English fast passenger locomotive, with a double compartment smoke stack, and having a novel arrangement for its cylinders and valve gear, is described in a recent number of London "Engineering." The engine is of the four-cylinder compound type, and was designed by Mr. F. W. Webb, Chief Mechanical Engineer, of the London & Northwsetern Ry. According to our contemporary, this locomotive has been in steady operation since Aug. 2 of this year, at first in fast express train service and more lately on the regular fast pessenger service between Crewe and Wellesden, making the trip of 152½ miles twice each day, without a stop.

The sectional side and front-end elevations of the forward part of the locomotive, which are reproduced herewith, show quite clearly the novel features of its construction. It will be noticed that the high pressure cylinders are placed outside of the frame, and the low pressure cylinders, inside, and that the two cylinders on each side exhaust into a separate compartment of the smoke stack. The arrangement of the smoke box for this purpose, and, further, to permit half of the tubes to lead into one compartment and half into the other, is to divide it into an upper and lower chamber by means of a horizontal plate or diaphragm. The exhaust pipes from the cylinders are clearly shown in arrangement and size by the drawings. The object of this double compartment construction is to secure a more equitable distribution of the draft between the upper and lower tubes, an object which is accomplished in American locomotives by the deflector plate, which is not used in England.

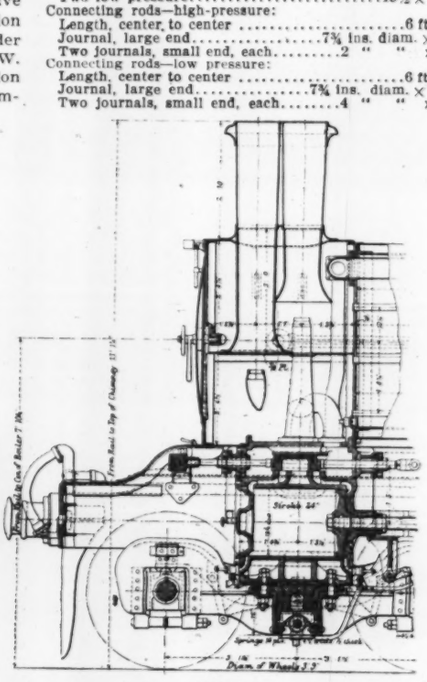
Another novel feature of the construction is the valve mechanism. Four slide valves are used, one for each cylinder, and one motion answers for each pair of valves. The construction is very simple. The valve motion used is the Joy, which is applied to the low pressure cylinder in the ordinary way. The valve spindle of the low pressure valve is prolonged through the front end of the steam chest and has on its forward a cross head, which connects with one end of a lever of the first order swinging in a horizontal plane. The opposite end of this lever is hinged to the valve stem of the high pressure cylinder valve. With this simple walking beam transmission, it is only necessary to adjust the pivot, or fulcrum, to get the requisite travel for the high pressure valve.

The locomotive is of the four-coupled driver type, the high pressure cylinders connecting with outside crank pins, in the usual manner, and the low pressure cylinders with cranks on the forward driver axle, inside the frame. The leading truck is of the four-wheeled type. The following are the mean dimensions of important parts of the engine:

Cylinders:	
Two high pressure	15 × 24 ins.
Two low pressure	19½ × 24 "
Connecting rods—high-pressure:	
Length, center to center	6 ft. 3 "
Journal, large end	7¾ ins. diam. × 5½"
Two journals, small end, each	2 " " × 2¾"
Connecting rods—low pressure:	
Length, center to center	6 ft. 3 "
Journal, large end	7¾ ins. diam. × 5½"
Two journals, small end, each	4 " " × 4 "
Coupling rods:	
Length, center to center	9 ft. 8 "
Journals	4¾ ins. diam. × 4 "
Wheels:	
Diameter, truck	3 ft. 9 "
Driving	7 " 1 "
Wheel base	23 " 2 "
Center of truck to center of driving	10 " 4½"
Center of driving to center of trailing	9 " 8 "
Weight on loaded radial truck	19 tons 16 cwt.
" driving wheels	17 " 8 "
" trailing wheels	16 " 14 "
Total weight	53 " 18 "
Boiler:	
Diameter outside (mean)	4 ft. 3 ins.
Length of barrel	11 " 0 "
Firebox:	
Length outside	6 " 10 "
Width outside	3 " 11 "
Height from center of boiler to bottom	6 " 4 "
Tubes (number)	235
" outside diameter	1⅞ ins.
Heating surface:	
Tubes	1,241.3 sq. ft.
Firebox	159.1 "
Total heating surface	1,400.4 "
Firegrate area	20.5 "
Tender, loaded weight	26 tons, 12 cwt.
Capacity of water tank	2,000 gallons.
Capacity for fuel	3 tons



Sectional Front Elevation.



Sectional Side Elevation.

LONDON & NORTHWESTERN RY. FOUR-CYLINDER COMPOUND LOCOMOTIVE WITH TWO-COMPARTMENT SMOKE BOX.
F. W. Webb, Mechanical Engineer, Designer.

A particular object aimed at in the construction of this locomotive, and which is indicated by the above figures, was to get all the bearing surfaces as large as practicable. Each of the four journals in the truck is 6¼ ins. in diameter by 10 ins. long. The driving axle, in addition to the two ordinary bearings, which are 7 ins. in diameter by 9 ins. long, has a central bearing between the two cranks, 7 ins. in diameter by 5½ ins. long. In the trailing axles the journals are 7 ins. in diameter by 13½ ins. long. The crank axle is of the built-up type, the crank wrist for each low pressure connecting rod being 7¾ ins. diameter by 5½ ins. long.

REPORT OF THE TRUSTEES OF THE NEW YORK & BROOKLYN BRIDGE FOR 1897.

A greater number of passengers was handled by the Brooklyn Bridge during the past year than during any previous year's operation of the bridge. According to the report of the Board of Trustees, which has just been issued, 45,542,627 passengers were carried by the bridge during the twelve months ending Nov. 30, 1897, or 3.5% more than were carried during the corresponding twelve months of 1895-6. The number of passengers carried each year for the past five years and the per cent. increase or decrease in passenger traffic is given as follows:

Year.	Total passengers.	Inc. or dec.*	Year.	Total passengers.	Inc. or dec.*
1892-3	42,615,105	+ 2.0	1895-6	43,990,459	— 1.2
1893-4	41,714,235	— 2.1	1896-7	45,542,627	+ 3.5
1894-5	44,564,329	+ 6.8			

*Per cent. of increase or decrease from preceding year.

The income for traffic for the year 1896-7 was $1,240,861. The income from all other sources was $122,869, making the total income $1,363,731. The expenditures for the year were $1,228,143, leaving a balance of $207,158.

The report outlines briefly the work of the Trustees for securing the running of both elevated and surface cars across the bridge from Brooklyn for a single fare. Both the plans of the special Board of Experts (Eng. News, Feb. 18, 1897), and the revised plans (Eng. News, Nov. 18, 1897), for this new service are described. The report states that work was begun immediately after the revised plans had been adopted and continued until an injunction was secured preventing further progress. Regarding the particular plans against which the injunction was directed the report says:

> The final revision consisted of locating the two surface railway tracks across the structure, along or near the inside of the roadways instead of along the outer margin, and connecting them with loops located within the New York station, on a level practically with the street; thereby eliminating stairs and elevators. Provision was made for the transit of footway passengers across these loops, either by a stairway and galleries at a height to permit the surface cars to run underneath and also by a subway to be placed at a proper distance below the present footway level.
>
> It seems proper to state, that any litigation which needlessly delays or prevents the bridge authorities from acting under the provisions of the law permitting the Trustees to make contracts with both the elevated and surface railway companies to cross the bridge will unfortunately retard what is regarded as a great public improvement, viz.: the actual physical consolidation of the railway systems of the two cities, which, when accomplished, will permit passengers to reach their destination without changing cars to cross the bridge and for a single fare of 5 cents. There can be no question but that the broad idea adopted by the present Board of Trustees of doing away with terminal stations for all bridges in Greater New York is progressive and correct. The public can best be served and the interest of the enlarged city most surely enhanced by making the present structure as nearly as possible a simple thoroughfare without passenger tolls. All future structures placed across the East River should be mere continuations of streets, and that is undoubtedly what they will be, unless constructed for a special purpose, such as the contemplated all-railroad and bicycle bridge, which cannot be built too soon to accommodate the rapidly increasing traveling necessities of the residents of the great city.

The preliminary injunction was secured on the plea that the operation of the electric cars at the street level would be dangerous to passengers using these cars and to people who would cross the tracks to reach the promenade and bridge railway platforms. This injunction was made

permanent by Justice Andrews, of the Supreme Court, on Nov. 29 and an appeal was taken by the Bridge Trustees. Arguments on this appeal are now being heard by the Appellate Division of the Supreme Court, and it is expected that a decision will soon be rendered.

The report states that up to the present date twelve hauling cables have been in use, of which nine are worn out and removed and three are yet in use. The period of service and quantity of work done by each is shown by the following table:

Cables	Days used.	Distance hauled, miles.	Total Passengers hauled.	Total Ton-miles hauled.	Average loads hauled, tons.	Av. ratio of live to dead loads.
1.	1,140	228,329	49,002,442	22,142,706	97.0	6.0
2.	667	129,232	47,840,262	25,492,892	212.0	7.3
3.	393	82,009	36,941,884	20,395,073	248.4	7.6
4.	356	74,111	34,134,469	18,923,469	255.3	7.6
5.	520	111,116	56,287,452	33,857,669	304.7	8.3
6.	509	109,475	58,071,052	35,149,894	321.1	8.4
7.	511	111,136	59,815,950	35,932,894	323.3	8.3
8.	446	100,268	53,047,435	30,950,941	308.7	8.1
9.	382	87,346	42,372,645	25,496,338	291.9	8.3
10.*	229	43,502	20,609,854	13,157,068	302.4	8.9
11.*	166	25,069	9,684,394	7,046,009	281.1	10.3
12.*	169	34,705	12,875,157	9,512,198	274.1	10.5

*Still in use.

Since the above was put in type the Appellate Division of the Supreme Court has handed down a decision quashing the injunction against the construction of surface railway tracks on the bridge. Work has been resumed on the construction and it is expected that the surface cars will be in operation by the end of this month.

THE ENLARGEMENT OF THE GRAND CENTRAL STATION, NEW YORK, N. Y.

The enlargement of the Grand Central Station, in New York city, which is now in active progress, besides being a work of considerable magnitude in building reconstruction, is also notable for the care which has been taken not to obstruct the regular use of the station by the railways and the public. This station was built 27 years ago and, as many of our readers know, the head house is L-shaped and fronts on both 42d St. and on Vanderbilt Ave. The trainshed occupies the rectangular space between the arms of the L, and the tracks entering it run parallel to Vanderbilt Ave. As the waiting-rooms, ticket offices, etc., are located in the Vanderbilt Ave. arm of the head house, all passengers, in order to get to trains standing on the further tracks, are compelled to cross the intervening tracks. With increasing traffic this arrangement has been a growing nuisance and in many other respects also the head house has become entirely inadequate to the enormous passenger traffic of the three railways which now use it. For some time, therefore, the officers of the New York Central & Hudson River R. R. have planned to remodel the station. In the Winter of 1895-6 the task was finally placed in the hands of Mr. Bradford L. Gilbert, as Architect, and Mr. Walter Katte, M. Am. Soc. C. E., as Chief Engineer.

The general plans for the remodelled station as developed by these experts are shown in the accompanying illustrations, Figs. 1, 2 and 3. Fig. 1 is a perspective view of the remodeled station, the 42d St. front being at the right hand side; Fig. 2 is a ground floor plan showing the rearrangement of the waiting-rooms, ticket office, baggage-rooms, etc.; and Fig. 3 is a cross section of one of the main towers, showing the additions made to it.

FIG. 1.—REMODELED GRAND CENTRAL STATION, NEW YORK CENTRAL AND HUDSON RIVER R. R. NEW YORK, N. Y.

Bradford L. Gilbert, Architect; Walter Katte, M. Am. Soc. C. E., Chief Engineer; Grace & Hyde Co., Contractors.

Figs. 1 and 3 have been reproduced from the "Railroad Gazette" of Feb. 19, 1897.

As will be seen, the plans contemplate the consolidation of the passenger and baggage business of the three railways. At the south end of the building will be the union waiting-room or rotunda, 100 × 200 ft., and 50 ft. high, while the baggage-room and other necessary auxiliary rooms will be in the Vanderbilt Ave. L of the building. All of these features are clearly shown by the plan Fig. 2. In addition, the office capacity of the building will be greatly increased by the erection of additional stories. Above the present second story ceiling the entire superstructure will be removed and rebuilt. The new portion will be of fireproof construction, and it is proposed further to fireproof the columns and floor beams of the old part left standing. The construction of these additional stories will increase the available office room from 55,000 sq. ft. to 133,000 sq. ft. Fig. 1 shows clearly the architectural appearance of the completed building. The walls will be of brick covered with artificial stone, concerning which the architect writes us as follows:

This is not the ordinary stucco, but is the first time that anything of this character, on so large a scale, has been attempted in this country, or any other so far as is known. It is not an experiment either, as work of a similar character has been attempted for many years, and the great majority of the larger public structures on the continent are formed of artificial stone to a certain extent. There has always seemed to be a prejudice against using artificial stone, and for this reason it took the architect of the station several years to satisfy himself upon its desirability and the advisability of using it in the station. The character of the material and the work will perhaps be better understood by referring to the use of artificial ice, which is as much ice as water naturally frozen, only the artificial ice is purer and better. Sandstone and limestone contain certain ingredients which are practically pure cement and are hardened by nature. When the same proportions of ingredients are used and hardened artificially, an artificial stone is produced which is just as much better in proportion to the original limestone as artificial ice is to natural ice. The backing of a plastic English cement against the old brick work of the building, becomes so hard in 24 hours, that it is impossible to pull it off without pulling out the brick, while the outside blocks of stone are cast in a German cement of especial hardness to withstand weathering, the two together forming an inseparable mass. The improved appearance of the building and the massiveness and solidity obtained by the use of this stone, is a subject of great interest and much comment by all interested and those who are familiar with the facts in the case.

The original structure was framed throughout on the exterior, including the corner quoins and heavy window casings and cornices, with cast-iron, which, when used 25 years ago, was a novelty and much cheaper than any stone moldings or blocks of a similar character could have been obtained, on account of the lack at that time of special machinery for cutting stone, which at the present time has reversed these conditions. Consequently it was desirable to carry out the new work in keeping with the old, by the use of cast-iron for the cornices, window casings, quoins, columns, pilasters, etc., and so far as known the present order for architectural cast-iron, which amounts to upwards of 700 tons, is the largest order ever known to have been given for this grade of work. While the models are made in the city, under the direct supervision of the architect, the actual castings are made in Indianapolis, at the only foundry which could cast them in this country, so far as known, excepting one foundry in New York city, which was in course of removal when this work was begun.

The mansards and domes of the towers are to be covered with natural copper, which will weather a verdigris antique green, thus forming with the entire iron work and stone work, which will be a natural limestone color, a most pleasing architectural effect, as well as a most durable structure.

The contract for the entire work was let to Grace & Hyde Co., of New York and Chicago, Ill., and construction is now in progress upon the additional stories to the head house, as is clearly shown by Fig. 4. In carrying out this construction a platform was built over the sidewalk at the level of the first story ceiling and extending along the whole front of the building on both 42d St. and Vanderbilt Ave., except for one small portion. The construction of this platform is clearly shown by Fig. 5. At about the middle of the Vanderbilt Ave. platform a bridge was thrown across the avenue and extended into the small private park opposite the station. This park was converted into a storage yard for material, and in it were also built the shops and offices of the contractors. As will be seen, the platform serves as a barricade to prevent debris from falling onto the sidewalk, but it also acts as a platform on which material used in construction is temporarily stored or transported to the place where it is to be employed in construction.

All material is stored in the yard and as it is wanted it is picked up by a derrick and placed on the end of the yard platform. Beginning at this point two lines of 30-in. gage track run to the sidewalk platform, where one curves to the left and the other to the right, and then continue on the outer edge of the sidewalk platform to its extremities. Along the inner edge of the sidewalk platform is a second track also extending the whole length. A cross-over on each side of the yard platform or bridge connects the inner and outer lines of track.

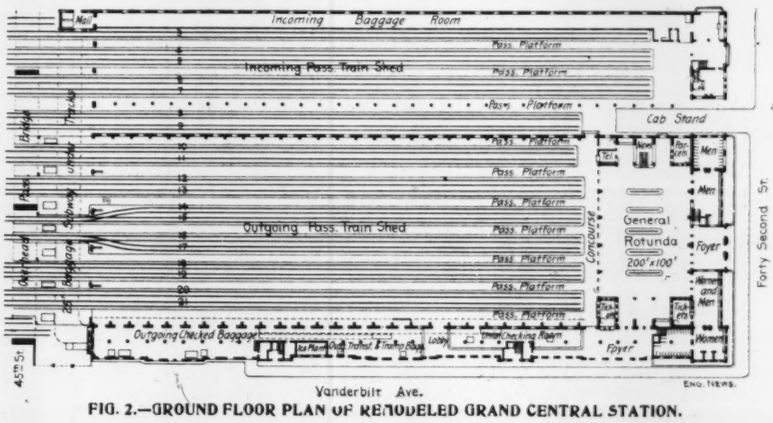


FIG. 2.—GROUND FLOOR PLAN OF REMODELED GRAND CENTRAL STATION.

The view, Fig. 4, shows the platform and track system quite clearly. It will be seen also that the mansard roof and walls of the old building have been removed down to the ceiling of the second story. A working floor has been built at the third story ceiling level and on it are mounted stiff-leg derricks. The same level is also supplied with material by two vertical hoists, the frameworks of

which are shown in the illustration. These hoists will be extended upward as the work progresses. By examining the hoist shown at the left hand it will be seen that it does not reach clear to the ground, but only to a platform above the sidewalk

constructed. This portion is shown at the extreme left of Fig. 4, and comprises the part of the station occupied by the express offices. As loaded wagons have to drive close up to building at this point the trestle work of such a platform as was built

station is shown in a general way by Fig. 2, there remain one or two special features which may be described before concluding this article. A very complete system for handling outgoing baggage is planned. As already stated, all outgoing baggage

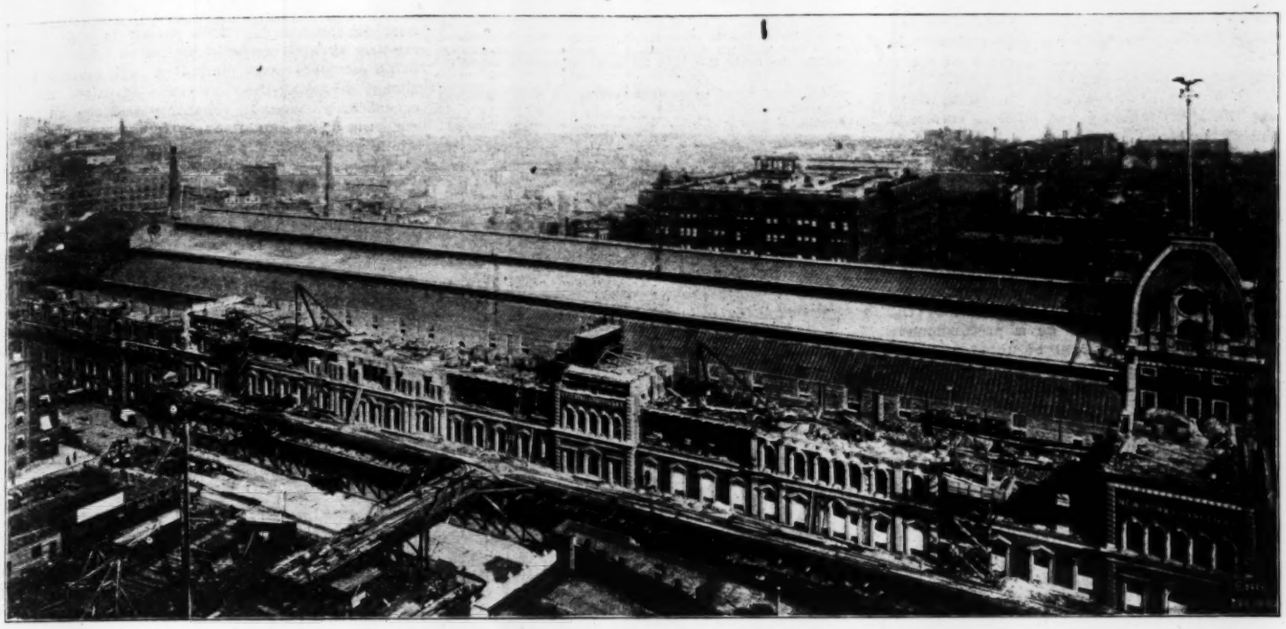


FIG. 4.—VIEW OF GRAND CENTRAL STATION, NEW YORK CITY, IN PROCESS OF RECONSTRUCTION.
(The View is looking toward the Vanderbilt Avenue front and shows the elevated working platform and track system.)

high enough to give ample head room below, and of sufficient area to permit the storage during the night of all the material which will be needed in construction during the day. This platform construction is pretty clearly shown by Fig. 5.

The order in which the various parts of the work is being done is about as follows:. The sidewalk cover was first constructed and equipped with its tracks. Work was then begun at the top, taking down the mansard roofs and side walls. The debris is removed in two different ways, depending somewhat upon its character. Generally the iron and timber are loaded onto the platform cars and taken to the end of the bridge, where they are run to the ground through a chute between the tracks. The piled-up debris below is hauled away by teams. The brick, plaster, etc., is removed in another manner. Generally these materials are piled up on the third story working floor during the day, and at night a train of gondola cars is run into the trainshed and the material is dumped into them through chutes extending down inside the trainshed. Considerable care had to be exercised in removing the roof and walls not to disturb the occupants of third story offices, some of whom did not move out. As soon as a sufficient amount of the walls and roof had been removed to make it possible the work of reconstruction was begun.

In this part of the work the platform tracks were again brought into use. The cars running on these tracks have removable bodies, provided with bails and hopper bottoms. For such material as can be carried in the box bodies the process of transportation is as follows: The yard derrick lifts the bodies to the ground, where they are filled, and replaces them on the trucks which have remained standing on the bridge tracks. The cars are then run underneath the stiff-leg derricks on the third story platform and their bodies are lifted by these and the load dumped through the hopper bottom. The steel I-beams and other members are loaded onto the trucks without the bodies, but are otherwise transported in the same way as fragmentary material. The operation of the vertical hoists will be understood without explanation, and all that needs to be noted is that by means of the storage platform all material is kept off the sidewalk.

It was mentioned above that along one portion of the building front no sidewalk platform was

elsewhere would have been a serious annoyance. At the same time some form of outside platform, and particularly a barricade against falling debris, were needed. The very simple and efficient construction shown by Fig. 6 was used. In many other parts of the work similar special constructions had to be devised, but the ingenuity of the contractors was most frequently required to devise systems of

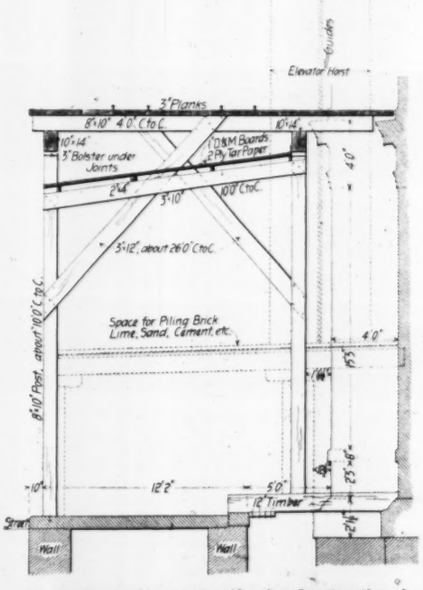


Fig. 5.—Transverse Section Showing Construction of Elevated Working Platform over Sidewalk.
(The broken lines show the intermediate platform and elevator shaft at the vertical hoists.)

shoring and bracing to support parts of the old structure which had their original supports removed. These constructions have been designed by the contractors, to whom the credit is also due of devising the general plan of construction adopted.

While the method of handling traffic in the new

is to be handled in the Vanderbilt Ave. arm of the head house. The baggage will be taken from the various baggage rooms and carried by conveyors (similar to the moving sidewalk at the Columbian Exposition) running underneath the floor, to the basement at the extreme north end of the building, where it will be transferred to baggage trucks and carried through a subway about 25 ft. wide running underneath the whole 20 tracks in the trainshed and its annex. At each truck platform there will be an elevator, 7 × 13 ft., which will raise the loaded trucks to the level of the platforms in the trainshed. This subway, it will be noticed, con-

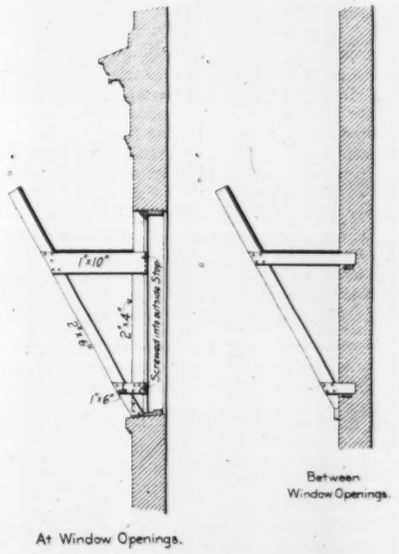


Fig. 6.—Construction of Working Platform over the Express Room Front on Vanderbilt Avenue.

nects the incoming baggage rooms. To supply power for operating the conveyors and elevators, as well as for electric lighting and ventilation, a 1,750-HP. plant will be installed in the basement under the outgoing baggage rooms. The total cost of the entire improvement, including reconstruc-

tion, additions and machinery, is estimated at about $1,000,000.

For the information from which this article has been prepared we are indebted to the contractors, Grace & Hyde, of Chicago, Ill., and the Architect, Mr. Bradford L. Gilbert.

NOTES FROM RECENT WATER-WORKS REPORTS.

During the construction of a new reservoir in the drainage area of the water supply of Cambridge, Mass., a number of cases of typhoid fever occurred in the drainage area, including some among the 2,000 laborers and officials employed by the water board. An advisory board was at once formed, made up of representatives of the city board of health, physicians in other towns and Prof. W. T. Sedgwick, of the Massachusetts Institute of Technology, the latter called in as an expert. A very thorough system of sanitary inspection of the drainage area, with disinfection of all polluting matter that might reach the brook, was established. Several dwelling houses and barns within the area to be covered by the new reservoir were burned as a precautionary measure. The incident might be noted with advantage wherever workmen are employed in large numbers within the drainage areas of city water supplies.

A water consumption of only 36.44 gallons per inhabitant, or 37.74 per consumer per day during 1896 is reported for Fall River. Of 6,704 services in use 5,607 are metered. Mr. P. Kieran is superintendent of the water-works.

Still less water than the above is used at Woonsocket, R. I., the consumption there having been 24.87 per inhabitant, and 26.72 per consumer per day in 1896. As at Fall River, this low consumption is largely due to the extensive use of meters, 1,599 out of 1,872 taps, or services, being metered at Woonsocket. The superintendent at this place is Mr. Byron I. Cook.

In striking contrast with the above, to name only one city, is Schenectady, N. Y., a place about the size of Woonsocket. Mr. Geo. T. Ingersoll, superintendent of water-works, here, assumes a population of 25,000, which would give an average daily consumption per capita of 208 gallons. Of 2,940 consumers only five are metered. Mr. Ingersoll urges in his report that all large consumers, at least, be metered.

In securing two new 10,000,000-gallon pumping engines for the water-works of New Bedford, Mass., the contract for all the steel forgings was let separately. Bids were invited from Frederick Krupp, of Essen, Germany, and from the Bethlehem Iron Works, of South Bethlehem, Pa. The bid of the latter was slightly the lower, and the contract was awarded to it. The engines were designed by Mr. E. D. Leavitt, M. Am. Soc. M. E., of Cambridgeport, Mass. Mr. R. C. P. Coggeshall is superintendent of the water-works.

Evaporation observations in connection with the water-works of Rochester, N. Y., were instituted in 1891. Two indurated fiber tubs, each about 15 ins. in diameter and 5¾ ins. deep, are used for measuring the evaporation, one tub being on and another floating in an opening in a raft. Recently a new apparatus was devised for use in freezing weather. This is described by Mr. Emil Kuichling, M. Am. Soc. C. E., Chief Engineer of the Water-Works, in his report for 1896, as follows:

> The records thus obtained for several years showed the loss which occurred from April to November, and also allowed a comparison to be made between the results from the exposed and the floating tub. It was, however, desirable to obtain the loss during the winter months as well, and in November, 1895, the apparatus was slightly modified for cold weather use by placing a 13-in. tub within one of somewhat larger diameter, so as to leave a small annular space around the outside of the former and also a space under its bottom. A flanged collar placed around the top of the inner tub prevents snow or rain from entering the spaces mentioned, and also checks any appreciable circulation of air therein. The inner tub can accordingly be lifted out from the other one at any time when the latter may be frozen firmly into the ice.
>
> To prevent the inner tub from being burst or damaged by the freezing of the contained water, a solid wooden cone, about 5 ins. in diameter at the base and 5¾ ins. high, loaded with lead so as to sink, was placed upright in the middle of the tub for the purpose of allowing the ice to rise upon its surface while in process of forming. By this simple expedient and the greasing of the sides, all injury to the tubs was obviated, and the device is now in service for its second cold season. The determination of the loss by evaporation is made by periodically weighing the inner tub with its contents upon a sensitive platform scale, due allowance being made in the computations for the slight reduction of area of water or ice surface caused by the projecting part of the wooden cone, as well as for rain and snow; and the results thus obtained in December, 1895, and during the past year, are given in one of the appended tables.

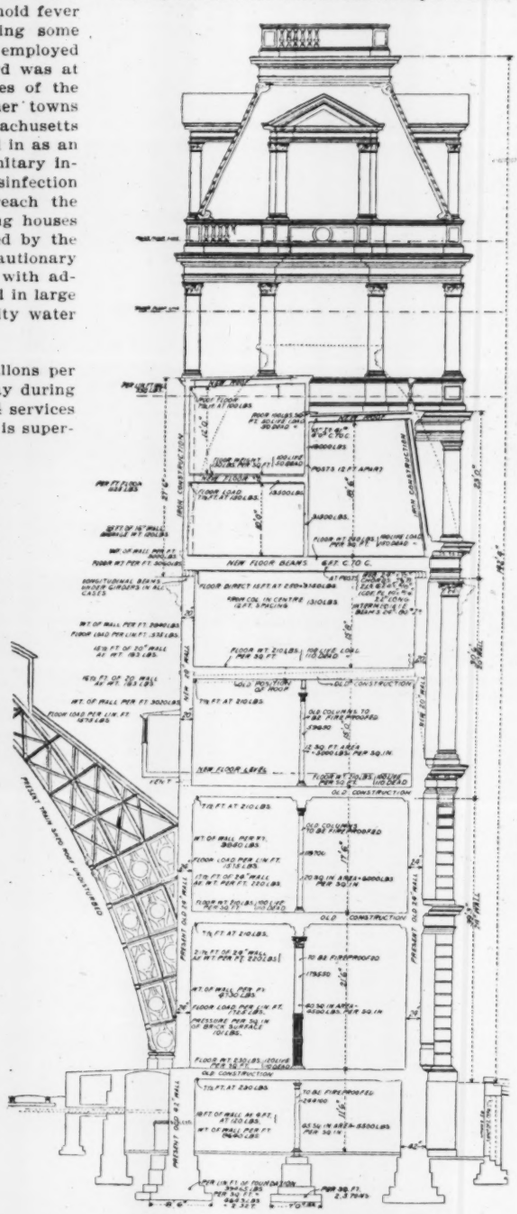


FIG. 3.—SECTION THROUGH TOWER OF GRAND CENTRAL STATION SHOWING ADDITIONS.
(The broken lines show the outline of the old tower.)

The evaporation in the modified form of floating tub for the four winter months of 1895-6 was as follows: December, 1.22 ins.; January, 0.45 in.; February, 0.45-in.; March, 0.91-in. The total evaporation for the year 1896 was 35.24 ins. from the floating tub against 42.99 ins. for the eight months of April to November, inclusive, from the exposed tub. The rainfall for 1896 was 25.5 ins. at the reservoir where the evaporation observations were made and the average mean temperature of the air was 47.7°F.

The history of the water-works of Detroit from the standpoint of an engineer is given in the report of the water board for 1896 by Mr. Gardner S. Williams, Assoc. M. Am. Soc. C. E., Civil Engineer to the board. This sketch is well worth reading by any one who wishes to know how to bring a water-works plant to a high state of efficiency, including the elimination of waste, the increase of pressure in reliability and amount, the ensuring of an ample supply for all purposes, the whole at the lowest possible cost.

Two exhaustive reports on water-works, to be established by municipalities now supplied by private companies have recently been made by different engineers. The municipalities are Traverse City, Mich., and Winnipeg, Man. Mr. George W. Rafter, M. Am. Soc. C. E., of Rochester, N. Y., reported for Traverse City, in conjunction with Mr. H. F. Northrop, M. Am. Soc. C. E., City Engineer. The Winnipeg report was made by Mr. Rudolph Hering, M. Am. Soc. C. E., Woodbridge Building, New York City. Both reports are interesting examples of the thorough investigations of water supply questions made by our best engineers when afforded an opportunity to do so. Mr. Rafter's report contains some good matter relating to the quality of the water of the Great Lakes at different points. Mr. Hering's report contains an estimate of the cost of a combined mechanical filtration and water-softening plant.

NOTES BY RAIL.

Cleveland, Cincinnati, Chicago & St. Louis Ry.

During the first part of the present year very little was done towards carrying out improvements, but the improved business and improved prospects have led to the undertaking of some of the projected works. It is proposed to lay about 90 miles of 80-lb. rails, releasing from the main track rails of lighter weight which have served their time and are ready to be removed to side tracks. No radical changes have been made in alinements or grades, but during the year 100 miles of track have been ballasted.

In the vicinity of Cincinnati, where the tracks were inundated during the high water last spring, ten miles of double track have been raised so that the line will not be interfered with unless the water goes 2 ft. higher than it did last spring. In other words, the track has been raised to such a height that it will require the water in the river to stand at an elevation of 63 ft., Cincinnati gage, before it will go over the tracks.

The general work which has been undertaken includes the remodeling of the yards at Greensburg, Ind., where the Michigan Division and Chicago Division cross each other. In addition to remodeling the present tracks, about 10,000 ft. of additional tracks are being laid. At Brightwood, Ind., the freight car repair yards are being extended by the addition of about 5,000 ft. of sidings. On the Cleveland Division arrangements are being made to extend a number of the passing sidings in order to accommodate the increased trains which are now being hauled under a tonnage basis as compared with those which were hauled before this system of loading went into effect.

At Benton Harbor, Mich., the road is rebuilding 1,000 ft. of its dock front and has established a coaling station and a slip at which car ferry boats land and transfer cars from the boats to the land.

Baltimore & Ohio R. R.

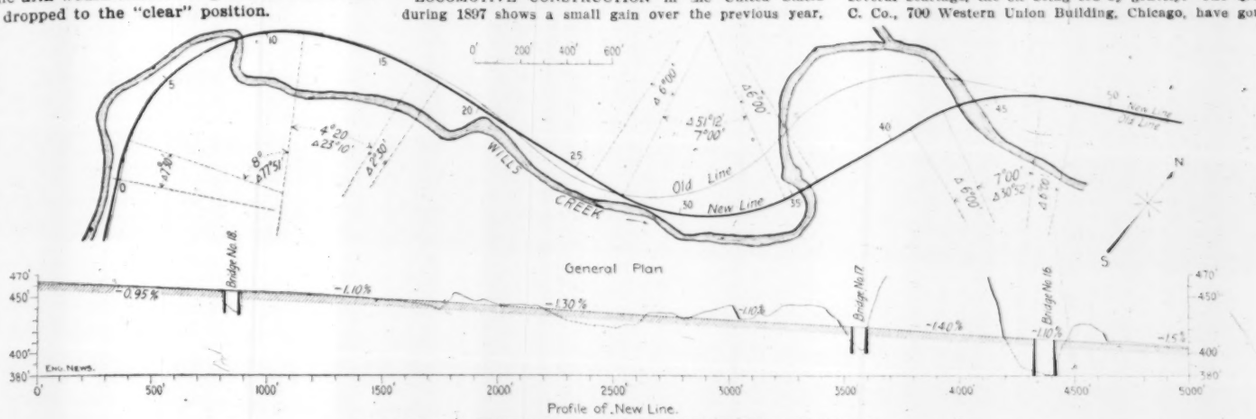
This road is one of the cleanest in the country, and after traveling over roads ballasted with gravel (which is usually of an inferior quality and very dusty), the absence of dust on the stone ballasted portion of this line is very noticeable. Extensive improvements are being made upon the track, new rails and stone ballast being laid, and changes made to reduce the curvature and grades in some places. Most of this work is on the eastern part of the line, especially in the Alleghany Mountains, and there does not seem to be much work in progress on the Chicago division, which is single track and ballasted with gravel.

The semaphore arms of the block signals are so

hung as to drop to a vertical instead of an inclined position when lowered to give a clear signal, and when lowered the arm is hidden by a fixed white board. This seems to be a bad arrangement, as it goes back to the old idea that no signal is a clear signal, which is distinctly opposed to the modern principles of signalling, which require a distinct signal to be shown to indicate "clear" or "stop." In the event of an arm being broken or knocked off, an engineman failing to see the arm would take it for granted that it had been dropped to the "clear" position.

RAILWAY CONNECTION BETWEEN MOSCOW and the White Sea was opened on Nov. 29, 1897, by the completion of a line from Moscow, through Yaroslav to Archangel. The distance is nearly 1,000 miles, and the running time is 3½ days, with one train per day. The northern section, of 400 miles, from Archangel to Vologda, runs through a practically unbroken wilderness of dense forests, swamps and dreary plains; but the line generally traverses a region rich in forest products and minerals. The road was built with English capital and materials.

LOCOMOTIVE CONSTRUCTION in the United States during 1897 shows a small gain over the previous year,



THE FALLS CUT IMPROVEMENT ON THE BALTIMORE & OHIO R. R.

In the train equipment are to be noticed many of the fine new locomotives and the new freight cars which have been described in our columns.

Among the numerous improvements being made in the general character of the road by the Baltimore & Ohio R. R. is a piece of realinement at what is known as the Falls Cut, on the Alleghany Mountain grade, 22 miles west of Cumberland, on the Pittsburg Division. Here the line passes through a deep cut in a spur of the mountain, and this cut has given a great deal of trouble for some years past, the topography being such that in case the sides of the cut should slide or cave in, the road might be blocked to traffic for a considerable time. In order to prevent such an accident the entire cut, 400 ft. long, 50 ft. deep, has been heavily braced with timber, but the new alinement will avoid this cut altogether and will also reduce the curvature, as shown by the plan.

The new part of the line is constructed for a double track, and the estimated cost of the improvement is $100,000, including 20,000 cu. yds. of excavation, 530 ft. of double track tunnel (30 ft. wide), 3,000 cu. yds. of bridge masonry, and three bridges, one of 80 ft. span and two of 60 ft. span. The work was planned under the direction of Mr. W. T. Manning, Chief Engineer.

A NICARAGUA CANAL CONVENTION is to be held in Kansas City on Jan. 17. A large attendance is expected, and the purpose of the convention is to urge Congress to appropriate money for building the canal.

THE ENGINEERS' STRIKE IN ENGLAND is said, by the labor authorities of London, to have cost the nation $75,000,000. The English Labor Department states that the 839 labor disputes of the last year have affected 201,638 persons, with an estimated loss of 10,000,000 working days, or 33,333 years of individual idleness. With an average daily wage of $1.14, for the men who have been idle, the actual wages lost would be $11,875,000. To this must be added the money paid out by the men's unions. The Amalgamated Society of Engineers reports $1,500,000 expended from contributions by members; the Boilermakers' Society has paid out $482,450; and the Labor Department places the total indirect and direct loss to the trades unions at $3,750,000. The general loss in British trade can only be estimated. The November returns of the Board of Trade show, for that month, a decline of $1,040,000 in value of shipments of machinery, as compared with November, 1896. For the eleven months of 1897 the decline was $1,660,000. Meanwhile Germany's export of machinery increased $2,375,000 in the first nine months of 1897. The Board of Trade returns figure loss on invested capital, loss of profit, loss of present trade and carrying trade, at $60,000,000. With the loss of wages and union payments added the aggregate loss due to the strikes of 1897 is figured as above at $75,000,000.

but has not got back to the figures previous to the panic of 1893. According to figures published by the "Railroad Gazette," the total number of locomotives built by private locomotive building establishments in 1897 was 1,251, as compared with 1,175 in 1896 and 2,011 in 1893. No figures are obtainable regarding the number of engines built by the railways themselves. Of the 1,251 locomotives built in 1897, 143, or 11%, were compounds, and 386, or 31%, were built for export. The "Gazette" has also obtained reports from 30 contracting car building companies and estimates from five others which show that the number of freight cars built in 1897 aggregated 43,588, as compared with 51,189 in 1896, 38,100 in 1894, and 18,000 in 1893. The "Gazette" finds among the car building companies reporting, one which built over 7,500 cars and three which built over 5,000 cars each.

TWO MASTODON FREIGHT LOCOMOTIVES weighing 212,750 lbs. each have recently been completed for the Great Northern Ry. by the Brooks Locomotive Works of Dunkirk, N. Y., and will be put at work on the heavy grades of the Montana Central Division between Great Falls on the east and Anaconda on the west side of the Rocky Mountains. These engines have simple cylinders and balanced piston valves, and their principal dimensions are as follows:

Driving wheels (8)	4 ft. 7 ins.
Truck wheels	2 ft. 6 ins.
Tender wheels	2 ft. 0 ins.
Wheel base, driving	15 ft. 10 ins.
" engine	26 ft. 8 ins.
" engine and tender	64 ft. 1½ ins.
Weight on driving wheels	172,000 lbs.
" " truck wheels	40,750 lbs.
Cylinders	21 × 34 ins
Valves	Piston
Valve travel	6½ ins.
Outside lap	1⅛ ins.
Inside lap	⅛ in.
Boiler	Belpaire
Outside diameter, largest	87⅜ ins.
" " smallest	78 ins.
Tubes, number	376
" diameter	2¼ ins.
Boiler pressure	210 lbs.
Fire box	124 × 40½ ins.
Grate area	34 sq. ft.
Heating surface, tubes	3,045 sq. ft.
" " firebox	235 sq. ft.
" " total	3,280 sq. ft.

A NEW METHOD OF CONSTRUCTING SURFACE CONDENSERS has recently been introduced by the South Brooklyn Steam Engine Works, D. McLeod Cobb, Proprietor, Summit and Van Brunt Sts., Brooklyn, N. Y. It consists in a method of alining, packing, and securing the tubes in the tube heads, within a reduced area of tube head and shell. By this means a condenser is made smaller in dimensions and of considerably less weight than can be effected by the usual method of construction. The tubes are securely expanded at one end, and packed at the other end with stay lacing and brass screw glands. They are not all packed in one tube head and expanded in the other, but are arranged in rows, alternately packed and expanded, one row being packed say, in the first head and expanded in the second head, and the adjacent rows expanded in the first, and packed in the second head, and so on. It is apparent that as the expanded holes are much smaller than the packing holes, and as half the number of holes in each tube head consists of the smaller holes, the tubes are brought much closer together, and the diameters of the heads, and also of the shell, are reduced.

LUBRICATION BY COMPRESSED AIR is a new invention which has recently been placed on the market. The usual way of oiling engines and other machinery is for a man to go around with an oil can and fill the oil cups. An improvement on this method is to have a system of oil pipes leading from a central source of supply to the several bearings, the oil being fed by gravity. The Q. & C. Co., 700 Western Union Building, Chicago, have gone a step further, providing a system which is independent of gravity or the rolling of a ship, and which can be controlled by one man from a central point. Its essential features are the feeding of the oil through the pipes by means of compressed air, delivering it to the bearings to be lubricated, and returning it from the bearings back to a filter near the central distributing point, and thence to the supply tank from which it is again sent around the circuit. The system is described and illustrated in a large circular, issued by the Q. C. Co., which we advise those of our readers who are in any way interested in this subject to procure.

THE TAYLOR HYDRAULIC AIR COMPRESSOR, the invention of Mr. S. H Taylor, of Montreal, in which air is compressed by means of a fall of water without the use of wheels, pumps, or other moving machinery, has been in successful operation at the Dominion Cotton Mills, Magog, Que., developing 155 HP., since August, 1896. Mr. Taylor has recently installed a plant at Ainsworth, B. C., in which the air is distributed to a group of mines 3½ miles distant from the compressor. On Dec. 15 he described his system at a meeting of the board of trade of Winnipeg, Man., where he hopes to introduce it. The system will be found described in an exhaustive paper on the "Air Lift Pump" in Engineering News of June 8, 1893. As there stated, this system of air compression was invented and patented by Mr. Joseph P. Frizell, M. Am. Soc. C. E., Jan. 29, 1878. To Mr. Taylor belongs the credit, however, for reducing the system to practice and putting it into operation on a large scale.

GAS ENGINES are rapidly replacing steam engines in the oil field that runs from Western New York to West Virginia. The natural gas from the oil wells has hitherto been used to generate steam to run the pumping engines of the wells and the pipe lines, but the quantity of gas has decreased, making it necessary to economize it, which the gas engine does. A letter in the Buffalo "Express" states that more than 300 gas engines have been placed in the oil region during the last year. They vary from 10 to 50 HP. and costs about the same as a boiler and steam engine of equal power. The Standard Oil Co. has fitted 20 of its pipe line pumping stations with gas engines.

VELNA BRIQUETTE FUEL, used in Germany, France and Belgium, is made of coal dust, bound together by petroleum residue, or the distillation residue from shale or other mineral oil, mixed with some convenient animal fat, and the whole then saponified by soda to an emulsion. Of this emulsion 1 to 2 cwts. is employed per ton of coal dust, and the mixture is pressed into shape in ordinary machines. Tests made at Brussels with this fuel show a total calorific power exceeding by 30% that or ordinary hard Belgian coal. At Paris it was demonstrated that a poor fuel was raised in calorific power from 4,000 to 6,400 calories, an increase of one-third, by the addition of 8% of the Velna mixture and compressed into briquettes. The various brown coals, usually developing 4,000 to 5,000 calories, can thus be converted into valuable fuel, yielding 8,000 calories. At the Cochet-Millard Works, in Paris, the boiler consumed from 165 to 176 lbs. of coal

in 3 hours to maintain a steam pressure of 143 lbs.; with 143 lbs. of anthracite dust, mixed with 8% of the Velna compound and pressed into shape, the same pressure was kept up for 3½ hours. For industrial purposes the cost of this Velna fuel is figured as follows by U. S. Consul M. Bouchsein: 94% of coal dust, at $1.09 per ton; 6% emulsion, at $11.52 per ton; working expenses, 38.3 cts. per ton; total cost of fuel per ton, $2.19. With 10% of emulsion, needed for poorer coal, the cost is $2.43 per ton. These prices are 25 and 16% cheaper than coal in these countries; and 15 cwts. of the briquettes produce as many calories of heat as one ton of coal.

THE CONDITIONS OF IRON MANUFACTURE in Alabama are changing, according to a letter by Prof. W. B. Phillips in the "Iron Trade Review" of Dec. 30. During the last five years the Birmingham foundry irons have changed their chemical constitution in the direction of lower silicon, so that No. 2 foundry now contains 2% or less of silicon, whereas it formerly contained 3% or more. High silicon iron is now becoming scarce. The cause seems to be the increasing use of the hard "lining," or self-fluxing ores, as the good soft ores are being worked out. The hard ores being low in iron it costs more to make a ton of iron from them than from the richer, soft ore. Prof. Phillips says that the absurd practice of grading the pig iron in the yard without reference to its composition still continues, and manifests an amazing vitality.

AN ARTIFICIAL ASPHALT is manufactured by Messrs. Fritz, Zoeller & Wolfers, of Berlin, Germany. It is made from coal tar, sulphur, chloride of lime and blast furnace slag, in unstated proportions, and is pressed into slabs from 2 to 10 ins. thick under hydraulic pressure of 200 atmospheres. It is intended for street paving and has been tested under pressure, in comparison with Sicilian asphalt, at temperatures ranging from 59° to 176° Fahr. The claim is made that at high temperatures it is slightly superior to the natural asphalt, and at ordinary temperatures it offers twice the resistance to pressure. No statement of comparative cost is made.

A PRIVATE PALACE STREET CAR is in operation in Cleveland, O., upon the electric lines of that city. This car was built for Mr. John J. Shipherd at a cost of $6,000, and while not the first palace street car, it may be considered the first entitled to the name. The interior of the car is dull finished in Mexican mahogany, while the roomy vestibules are polished cherry. The window panels contain thick beveled-edged mirrors. All metal parts are of polished bronze. The ceiling is decorated with panels in color, representing scenes from the life of Minerva, for whom the car is named. Neat electroliers furnish light for the interior, while unusually bright headlights are provided. The customary fixed seats are replaced by 10 rattan easy chairs, with plush cushions. Electric heaters and various other devices are employed to increase comfort and safety.

BOOK REVIEWS.

THE MONEY QUESTION.—A Hand-Book for the Times. By Henry V. Poor, Author of Money and Its Laws, Poor's Manual of the Railroads of the United States, Etc., Etc. New York: H. V. & H. W. Poor, 44 Broad St. Paper; 6 × 9 ins.; pp. 202.

This pamphlet is a review of the monetary system of the United States, and a discussion of what that system should be in the future. The author states in his preface that throughout the volume "money is treated as a subject coming within the range of the exact sciences."

AMERICAN RAILWAY MANAGEMENT.—Addresses Delivered Before the American Railway Association and Miscellaneous Addresses and Papers. By Henry S. Haines, M. Am. Soc. C. E., General Manager Plant System of Railway and Steamship Lines. New York: John Wiley & Sons. Cloth; 5×7½ ins.; pp. 368.. $2.50.

Mr. Haines, who is well known as a prolific writer and speaker on railway topics, has collected in this volume 21 addresses and papers delivered or published by him at various times from 1884 to 1897. As might be expected of a collection of papers and addresses written often on the spur of the moment and sometimes on subjects of merely current interest, the contents of the book are of quite uneven value. Some of the more carefully prepared papers are of unquestionable merit, but others might well have been revised and expanded, and a few could better have been omitted altogether. We fully recognize Mr. Haines' great abilities as a railway manager, and appreciate the fact that he possesses a breadth of vision and a soundness of opinion in the discussion of the larger economic questions of railway policy, which are all too rare. Many of his public utterances well deserve the permanent form which they have here taken; but some of the others which have been included in this volume were never intended by their author, we believe, to do more than interest an after-dinner audience or enliven the proceedings of a convention, and their omission from the present volume would have made it a fairer presentation of the abilities of its author. Such a condensation of the contents, moreover, would have brought the size of the book within such limits that it could have been sold at a much more reasonable price. It hardly needs to be said, after the above remarks, that the subtitle of the book more nearly indicates its true nature than does the main title. The book is well printed and neatly bound, and has an adequate index.

THE YEAR BOOK OF RAILWAY LITERATURE.—Edited by Harry Perry Robinson, The "Railway Age," Chicago, Ill. Cloth, 6 × 9 ins.; pp. 427. $1.

The object of this publication is stated in the preface to be, "to put annually into permanent form all papers or addresses on the public relations of railways, appearing or being delivered during the year, which seem to have enduring value." A very good understanding of the contents of the present volume is given by quoting the titles and authors of the various articles. These are as follows: "Railway Pools, Their Equity and Public Value," by Geo. P. Blanchard; "The Trans-Missouri Decision," by Geo. P. Blanchard; "The Pooling of Railway Earnings," by Adaee F. Walker; "The Industry of the Rail," by E. B. Thomas; "The People and Their Railways," by E. T. Jeffery; "An Address to Railway Men," by E. T. Jeffery; "Railways and the Public," by T. B. Blackstone; "Railways and Their Revenues," by C. P. Huntington; "Railways—A Retrospect," by M. E. Ingalls; "Railway Rates and Earnings in Kansas," by E. P. Ripley; "Rate Reduction in Kansas," by E. P. Ripley; "Two Cents per Mile Passenger Rates," by James Charlton; "The Railways of Illinois," by Dwight C Morgan; "An Argument on the Two-Cent Fare Bill," by W. C. Brown; "Passenger Rates in Iowa," by W. W. Ainsworth; "The Railways of Georgia," by Frank Weldon; "Are American Railway Rates Too High," by H. S. Newcomb; "The Railway Problem," by Lloyd Bryce; "The Plight of the Railways," by Robert T. Porter; "Business Interests and the Pooling Bill," by Robert T. Porter; "The Scalping of Railroad Tickets," by Geo. H. Daniels; "The Limitations of Governmental Regulations of Railroads," by Joseph Nimmo, Jr.; "The Trans-Missouri Decision," full text of Supreme Court decision; "The Rate Making Power of the Interstate Commerce Commission," full text of Supreme Court decision.

To persons interested in questions of railway economics and legislation this collection of the best articles appearing during each year will be found very convenient, and it will be the wish of all, we think, that the present volume of the "Year Book" shall receive such appreciation as will warrant its continuation. A good index makes it possible to find easily references to common subjects, which is often a tedious matter in searching for information through a miscellaneous list of articles written by different persons.

THE WATER COMPANY'S DIRECTORY AND STATISTICS (Revised to July 1, 1897), with a List of Chairmen, Managers, Engineers and Secretaries, and List of Associations of Engineers and Managers. London: Hazell, Watson & Viney, Ltd., 1 Creed Lane, E. C. Cloth; 6 × 9 ins.; pp. xxviii., 93; 6 shillings.

This is the twenty-third issue of a volume which does for the water-works of Great Britain and Ireland what The Manual of American Water-Works does for those of the United States and Canada, although in a much more limited way. A few foreign works are described in the English publication, but nothing like all of those in the foreign possessions of England. The scope and arrangement of the information in this volume is about as follows: Population supplied; railways serving the town, with distance from London, Edinburgh or Dublin; ownership and date of instituting works, including dates of special acts; capital stock, bonded debt and dividends; death rate, source of supply and hardness of water; area supplied; storage capacity; total annual consumption and average per capita per day; assessment charge on rental value of property, meter rates and total revenue per year; number of meters and length of mains; list of officials.

The information given, so far as it goes, is of the right sort, the facts given being those which are of the most importance, with two or three possible exceptions. One would like to know, to name only two things, something regarding the presence or absence of purification works, and the number of taps or service pipes, the latter being of value in connection with studies of the effect of meters upon consumption and waste. It would also be interesting to know, without having to count it up, page by page, how many water-works are described in the book, and how many of these are owned by private companies and how many by the municipalities served.

Altogether the publication is a most creditable one. The fact that it has continued through so many successive issues seems to attest its appreciation in England. American water-works officials and students of municipal problems might also find the book of value. From time to time we receive inquiries for a book on English water-works similar to The Manual of American Water-Works. This publication comes the nearest to it of anything we have ever seen and we recommend it to those interested in English water-works statistics.

THE GAS AND ELECTRIC LIGHTING COMPANIES' DIRECTORY AND STATISTICS (Revised to July 1, 1897), with a List of Chairmen, Managers, Engineers and Secretaries, and Lists of Associations of Engineers and Managers of Gas and Electric Light Undertakings in All Parts of the World. London: Hazell, Watson & Viney, Ltd., 1 Creed Lane, E. C. Cloth; 6 × 9 ins.; pp. LXXII., 336; 6 shillings.

This volume relates primarily to the gas and electric lighting works of Great Britain and Ireland, but contains in addition a number of foreign works, including some located in the United States and Canada. For gas works the volume aims to give the population supplied; distance of the town from London, Edinburgh or Dublin, according to the country concerned; the owner of the plant; date instituted; stock, bonds and dividends; coal carbonized; annual make and sale of gas; candle power prescribed and furnished; number of consumers and number of public lamps, with prices for private and public consumption; price received for coke and kind of residuals made; miles of mains; and list of officers. For electric lighting plants much the same line of information is given, allowing for differences in the nature of the undertakings.

Anyone interested in the number of gas or electric lighting plants described, the division of the same between public and private ownership, or anything else relating to general practice, must make the necessary summaries to ascertain these facts, everyone for himself. It is worth a great deal, however, to have so much and so apparently complete information available as is here given, even if the publishers have failed to greatly increase the usefulness of their book to certain classes by putting a slight amount of additional labor upon it.

APPLIED MECHANICS.—A Treatise for the Use of Students who have Time to Work Experimental, Numerical and Graphical Exercises Illustrating the Subject. By John Perry, M. E., F. R. S., Professor of Mechanics and Mathematics in the Royal College of Science, South Kensington, Etc. D. Van Nostrand Co., New York. 12mo.; cloth; pp. 678; 371 illustrations; $2.50.

Professor Perry is the author of a work on "Calculus for Engineers," which was recently noticed in our columns. The present book shows all the peculiarities of the author's style, which are shown in his work on "Calculus," and shows also in even a more marked degree his abilities as a teacher and writer. By using a great deal of fine type he condenses in his 678 pages about twice as much matter as is found in the ordinary textbook on mechanics. We quote the following extracts from the preface and the introductory chapter to show the purpose and scope of the work:

This book describes what has been for many years the course of instruction in Applied Mechanics at the Finsbury Technical College.

Professor (now Sir Robert) Ball, at the Royal College of Science, Dublin, started quantitative experimental mechanical work. He used the well-known frame of the late Professor Willis, which was taken to pieces and built up in new forms for fresh experiments. What I have done has been to carry out Professor Ball's idea, using a distinct piece of apparatus for each fresh kind of experiment. A student measures things for himself; illustrates mechanical principles; finds the limits to which the notions of the books as to friction and properties of materials are correct; learns the use of squared paper, and the accuracy of graphical methods of calculation; and, above all, really learns to think for himself.

It was found in time that students took very eagerly to the quantitative experimental work, and that the whole system, faithfully followed, produced men whose knowledge was always ready for use in practical problems, and who knew the limits of usefulness of their knowledge. I am glad to say that more than twenty complete sets of the apparatus have been made and sent to various institutions.

The student of Applied Mechanics is supposed to have some acquaintance already with the principles of mechanics; to be able to multiply and divide numbers and to use logarithms; to have done a little practical geometry; and to know a little algebra and the definitions of sine, cosine and tangent of an angle; and to have used squared paper. He is supposed to be working many numerical and graphical exercises; to be spending four hours a week at least in a mechanical laboratory; to be learning about materials and tools in an iron and wood workshop; and to be getting acquainted with gearing and engineering appliances in a drawing office and elsewhere.

We commend Prof. Perry's book to the attention of teachers of applied mechanics. It should be a valuable work to have on the desk for reference, especially on account of the vast number of problems and exercises it contains, and the numerous suggestions for simple laboratory experiments by which the student may gain a clearer insight into mechanical principles than he can obtain by mathematical analysis. Many of the author's statements are open to objection on account of their introducing unusual terms and definitions and their want of clearness and precision. We quote the following as examples:

Force may be defined as the space rate at which work is done, or any form of energy converted into another, or it may be defined as the time-rate of transference of momentum.

When we speak of the tensile strain in the wire we mean the fraction of itself, by which it elongates. Stress is the load per square inch which produces a fractional elongation of the length of a curve or rod.

M is a number which ought to be known for every fly-wheel. It is just as important to know the M of a fly-wheel as to know the weight of an ordinary body. . . . The mathematicians do not use our M.

If mathematicians do not use the M, and designers and builders of fly-wheels do not use it, so far as we know, its importance is not self-evident. As most of our readers probably do not know what the M of a fly-wheel is, we may explain that it is a number which when multiplied by the square of the number of revolutions per minute will give the stored energy in the wheel corresponding to that number of revolutions.

Notwithstanding these peculiarities of the book, its general excellence is such as to make it a valuable addition to mechanical literature.